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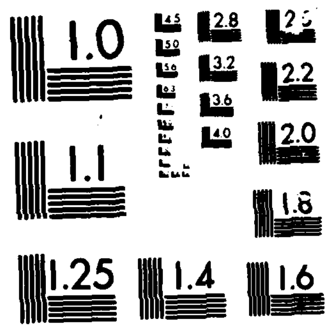

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ABSTRACT

Electrical resistance studies were conducted in two laboratory models to determine electrical resistivity relationships and to use those defined relationships to identify contamination spikes. A good correlation was established between resistance data and the composition of leachate and copper spiked leachate gelatin blocks under study.

The major variable that could not be eliminated from this study which had the greatest effect on data was moisture content.

This thesis contains a review of the theory and field application of electrical resistivity, a description of the experimental approach used, and a summary of the data collected.

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STUDY OF ELECTRICAL

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A Thesis submitted to the

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by

Brian D. McCarty

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CHAPTER 1 - INTRODUCTION

The Resource Conservation and Recovery Act (RCRA) of 1976 has forced the identification, reporting, and correction of environmental deficiencies from past waste management activities.

These past waste management activities have resulted in serious groundwater contamination and possible contaminant migration. This leaves two major problems to be resolved. First, an accurate method for delineating the area of contamination and the extent of contaminant migration. Secondly, a permanent solution to the contamination which employs the proper technological method based on contaminant characteristics, area hydrology, depth of contamination and soil type.

The environmental engineer, hydrologist and geologist have combined their efforts to resolve the aforementioned problems. This combined effort will lead to a permanent, cost effective solution tailored to each contamination problem.

PROJECT DESCRIPTION

The basis for this project is an adaptation of the field method using electrical resistivity to locate geologic structure and groundwater. This field method did not have great success in locating and identifying contaminate plumes because of the many varied interferences.

By eliminating as many interferences as possible, it was hoped that background electrical resistivity values could be established for the two laboratory models used. Also, that the electrical resistivity data taken would show a direct correlation between the electrical resistivity reading obtained and the contamination spikes in gelatin. The laboratory model design, procedures, and methodology were created to obtain a correlation between resistivity and contamination.

OBJECTIVES

There were two main objectives of this thesis. First, to define the relationships of electrical resistivity as it applies to subsurface mapping, and second, to use electrical resistivity data in characterizing contamination.

The conclusions presented here are the results of studies in two different laboratory models. The basic principles of electrical resistivity for subsurface mapping were defined in a small aquarium (10 inches wide by 10 inches deep by 20 inches long). Electrical resistivity principles were then used to identify contaminants in a large tank (2 feet wide by 5 feet deep by 18 feet long).

LITERATURE REVIEW

A literature review on the theory and application of electrical resistivity showed three major uses of electrical resistivity data. Originally the method was used successfully as a geophysical mapping technique to determine location of layered structures. Later, the method was adapted to map water tables and determine aquifer parameters. More recently, electrical resistivity studies have shown some success in

delineating groundwater contamination and mapping saltwater - freshwater interfaces.

Geophysical exploration using electrical resistivity centered around the comparison between field resistivity readings and standardized resistance curves for multi-layered sections. These standardized resistance curves, called Dar Zarrouk curves, were developed in the late 1940's. Later work by Orellana described a graphical method for the simple calculation of Dar Zarrouk curves. Zohdy later developed the method of relating vertical electrical sounding data to Dar Zarrouk curves. The application of Dar Zarrouk curves and these more recent developments have shown great success in defining geologic layers using electrical resistivity.

The next adaptation was the use of electrical resistivity data to map water tables and determine aquifer parameters. Yazicigil and Sendlein summarized that electricity was conducted by the interstitial fluid in the rock and not by the lattice of the material itself. Because of this fact, resistivity was controlled more by porosity, water content and water quality than by the actual rock matrix. Electrical resistivity data then became a good indicator of the subsurface water content. The higher the porosity, the lower the resistivity. Similarily, the higher the

salinity of the groundwater, the lower the resistivity due to the increase of chloride ion present.

Urish tried to develop a model relating the formation factor to hydraulic conductivity in an effort to determine various aquifer parameters. The formation factor, as determined by Archie in 1942, is the porewater resistivity divided by the bulk matrix resistivity. Urish found that the relationship is strongly dependent on field factors, such as porosity and geologic layering. Further, the characteristics of the resulting formation factor - conductivity curve depend greatly upon the aquifer composition and porewater resistivity.

Both the summary by Yazicigil and Sendlein and the study by Urish showed electrical resistivity as a valuable method in groundwater exploration. Its use for qualitative comparison of sites, however, is limited unless parameter variations, such as porewater resistivity, aquifer composition, and porosity are clearly defined.

The current adaptation of electrical resistivity data is for the identification and quantification of contamination plumes. A study by Ringstad and Bugening evaluated electrical resistivity data to determine areas of groundwater with acceptable total dissolved solids (TDS) levels. They also found that geologic

resistivity was controlled more by water content and water quality than by the conductivity of the matrix materials. The results of their studies produced one test well with acceptable TDS levels and one test well with high TDS levels.

A study by Warner on five Long Island sites and three Texas sites to delineate zones of contaminated groundwater showed that a good relationship existed between contamination and electrical resistivity data when a high resistivity contrast between contaminated and uncontaminated water can be found. Three of the five Long Island sites and one of the three Texas sites showed a good correlation between electrical resistivity data and actual groundwater contamination. The author felt that topography variations, soil characteristic variations and buried electrical conductors accounted for the failures of this predictive method at the other sites.

A summary by Urish on the practical application of using electrical resistivity to detect groundwater pollution highlighted three points. First, that geoelectric profiling is a cheap and quick means of locating recovery and test wells, if the conductive contrast between the contaminated groundwater and clean groundwater is high. Next, that electrode spacing for data recording is crucial to the detection of the low

resistivity values associated with contaminated zones. Finally, that thin contaminated layers may be hidden by the electrical resistivity effects of other geologic layers.

Paul Roux evaluated the success of electrical resistivity evaluations at solid waste disposal facilities. He found that variations in electrical resistivity values can reflect the presence of varying geologic strata and also the presence of contaminated water, but the method cannot accurately distinguish the cause of varying electrical resistivity values. He felt that electrical resistivity should be used to locate optimum monitoring well location, but it should not replace direct water sample analysis from monitoring wells.

An evaluation by Klefstak, Sendlein and Palmquist on the limitations of electrical resistivity used in landfill investigations showed that a correlation existed between resistivity readings and geomorphic position, but that no apparent relationship existed between resistivity and water quality. The authors felt that variations in landfill soil characteristics and overcoming the threshold resistivity of the soil were the two major factors preventing a relationship between resistivity and water quality.

Cartwright and McComes used geophysical surveys to locate groundwater around a sanitary landfill and map the associated geologic characteristics. They found the electrical resistivity survey to be a low cost, accurate method for well location, however, resistivity values overlapped with soil types, soil layers, groundwater quantity and groundwater quality. Also, their results showed difficulty in identifying thin aquifer layers less than 20 feet thick. The Cartwright - McComes study did show resistivity data to be indicative of recharge areas, groundwater movement, and general contamination composition.

Finally, a landfill study by Stollar and Roux summarized the problems in using electrical resistivity for groundwater qualification. Stollar and Roux did not produce a definable relationship between resistivity and groundwater contamination due to extreme lateral geologic variation, a deep water table, man-made obstructions in the landfill and small electrical resistivity differences between natural groundwater and contaminated groundwater.

CHAPTER 2 - ELECTRICAL RESISTIVITY

THEORETICAL CONCEPTS

There are four basic concepts used in understanding electrical resistivity and its application to the current geologic techniques. They are voltage, current, resistance and resistivity.

Voltage (V) is defined as the work done on a unit charge between two points, as that unit charge is moved from point one to point two. Voltage is also called the potential difference between two points and is measured in volts (V).

The next definition required in describing circuit elements is current (I). The current at any cross section in a conductor is the limit of the ratio of positive charge passing that cross section to the time interval during which the charge was measured. Current takes on the significance of the timed rate of change of the charge and is based on the fundamental principle of the conservation of charge. Current is measured in amperes (A), and is defined as the rate of movement of charge passing a given reference point of one Coulomb per second.

Resistance (R) is the proportionality constant relating the voltage across the circuit to the current

going through it. The defining equation for resistance is given by Ohm's Law as: $V = IR$ (Equation 1)

Resistance is measured in Ohms (Ω), and becomes the important variable of circuits with a known voltage and known applied current. By knowing the voltage applied to a solid and the current passing through the solid, the resistance of the solid can then be determined.

All solids fall into the three general categories of conductors, semiconductors and insulators. These terms refer to the ease with which electrical charge can pass through the solid material. A conductor would permit easy electrical charge passage while an insulator would slow the electrical charge passage through the solid.

From this standpoint, the term resistivity (ρ) can be defined as a measure of the ease of electrical conductance per unit of length. Common values of resistivity readings are in Ohm-feet or Ohm-meter.

The current density (J) in solids can be defined by the equation:

$$J = \sigma E \qquad \text{(Equation 2)}$$

where σ is the conductivity property of the material and E is the electric field intensity applied to the field.

From this equation, and Equation 1, the ordinary resistance of a uniform solid of length (l) and area (A) can be derived as follows:

$$R = \frac{V}{I} = \frac{El}{JA} = \frac{El}{\sigma EA} = \frac{l}{\sigma A} = \frac{\rho l}{A} \quad \text{(Equation 3)}$$

where the resistivity (ρ) is the reciprocal of the conductivity (σ). The conductivity or resistivity of a given solid depends on the internal lattice structure of the solid.

Resistivity through a solid cube of 1.0 foot dimensions can be defined as the resistance across the opposite face of the cube as shown in Figure 1. In this case a resistance of 1.0 Ohm would equal a resisitivity of 1.0 Ohm-feet.

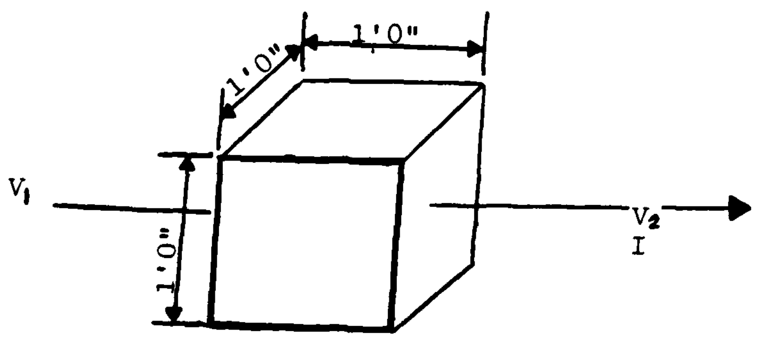


Figure 1

FIELD EVALUATIONS

The geologic adaptation of electrical resistivity is called an Electrical Earth Resistivity Survey (EERS). The purpose of the EERS is to measure the resistivity over a large volume of earth. The resulting resistivity reading is then interpretated for the various soil types, soil layers and moisture conditions found. Variations in geologic structure and moisture content cause the most problems with data intrepretation.

With the exception of some clays and metallic ores, the passage of electricity through the ground takes place using the groundwater contained in the pores and fissures of the rocks. Holding all things constant, an increase in dissolved salts in the groundwater would tend to decrease the resistivity reading. Similarly, increasing the water content and filling the existing pores, will decrease the resistivity value.

For field evaluations, a basic resistivity set-up is shown in Figure 2 on page II-5. The typical voltage applied is around 90 Volts and the measured circuit current is around 20 milliamperes for the Bison Instrument Model 2350.

The current applied to the earth will distribute itself evenly over the large volume of earth. The current along the surface will produce a voltage drop between the inner two probes as shown below.

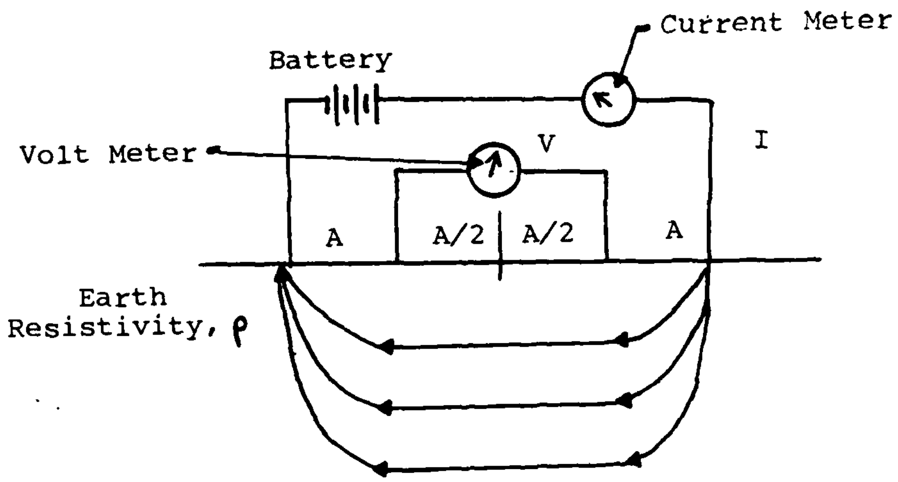


Figure 2

Otellana and Mooney determined that if the earth volume were completely uniform for the above electrode spacing, the following equation defining resistivity would apply:

$$\rho = 2\,\frac{\pi A V}{I} \qquad \text{(Equation 4)}$$

Because large volumes of earth are never uniform, the right side of Equation 4 is termed the "apparent resistivity", not the true resistivity of the medium.

Field meters, such as the Bison 2350, provide a direct measurement of ($2\pi V/I$) which gives a more accurate and convenient reading.

The three most widely used electrode spacings and configurations are shown in Figure 3 on page II-7 with each one having its own characteristics and advantages. These three major configurations are the Wenner Configuration, Lee Modification of the Wenner Configuration, and the Schlumberger Configuration.

Sweeney's article comparing the various electrical resistivity methods stated that these dipole-dipole arrangements give better information about changes in electrical resistivity with depth. This leads to easier data modeling for comparison to known geologic conditions.

The Wenner Configuration is the preferred field method due to its simplicity and the easy interpretation of electrical resistivity data. The Lee Modification adds an additional electrode in the center to enhance horizontal and vertical variations in subsurface configuration, while the Schlumberger Configuration places the inner two (potential) electrodes closer together and is preferred in resistivity sounding measurements.

Once the data is obtained over the area surveyed, it is plotted, either linearly or logarithmically, with

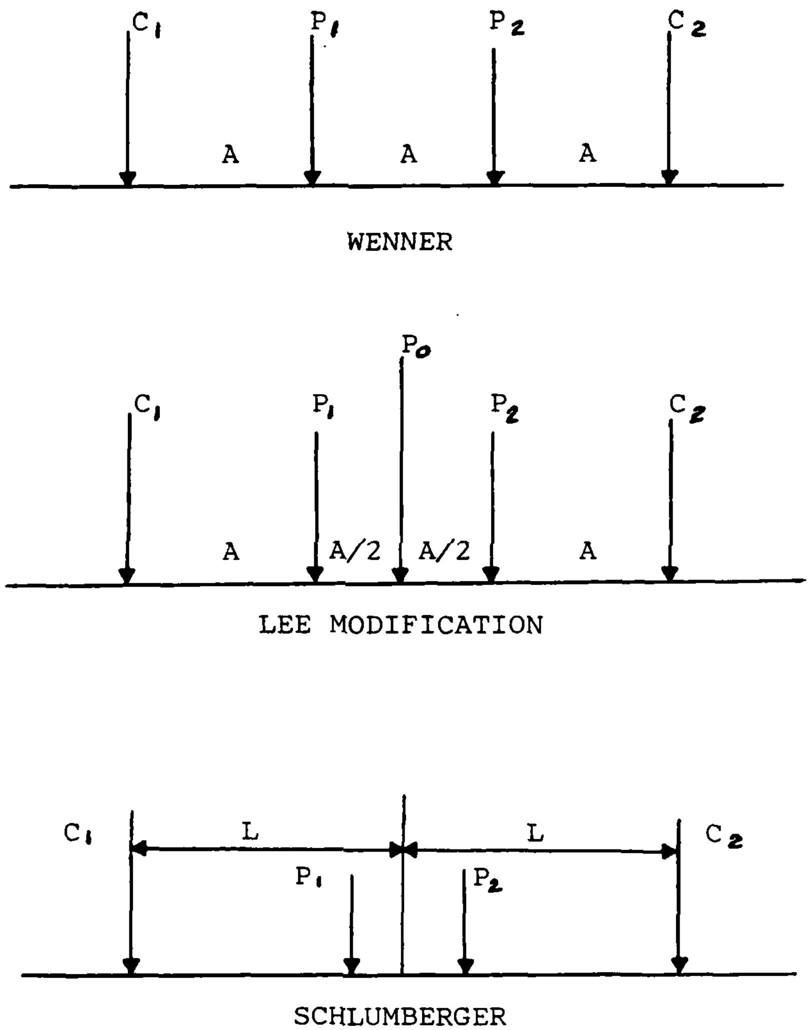

C_1
P_1
P_2
C_2
A
A
A
WENNER
P_0
C_1
P_1
P_2
C_2
A
A/2
A/2
A
LEE MODIFICATION
C_1
L
L
C_2
P_1
P_2
SCHLUMBERGER

Figure 3

apparent resistivity on the y-axis and the electrode spacing on the x-axis. Data can also be summarized on a resistivity contour map for easier visual inspection.

To aid in the interpretation of field data, several authors have developed standard electrical resistivity curves for layered geologic situations. Once an approximate solution has been obtained from curve matching the field data to the standard curves, the layer parameters can be determined from a curve generating computer program which tests the closeness between the field values and the computed resistivity values. The general standard for curve matching interpretation comes from the Dar Zarrouk curves discussed earlier.

Typical field resistivity values will range from 1 to 100 Ohm-feet for low resistivity soils, 100 to 1,000 Ohm-feet for medium resistivity soils, and 100 to 10,000 Ohm-feet for high resistivity soils. Values in the 10,000 Ohm-feet range are indicative of massive igneous rocks. Sand will fall into the category of a high resistivity material, particuarly when dry. As the sand becomes water saturated, electrical resistivity values begin to drop as water begins filling the pore spaces between sand particles and increases the conductivity of the sand.

Electrical resistivity values will tend to decrease with an increase in the amount of water in the pore spaces and will also decrease with an increase in the salinity or free ion content of the water in the pore spaces.

CHAPTER 3 - EXPERIMENTAL APPROACH

PROJECT SCOPE

The project was divided into two distinct phases. The first project phase included the set up of the laboratory models, the development of the operational procedures, and the scale-up of these parameters to the large flume. The second phase included the development of a relationship between electrical resistivity data and contaminant identification.

Phase one was ongoing throughout the length of the project. More specifically, it included the preparation of both laboratory models, moving the Ottawa sand into the flume, designing and installing a water evacuation system for the flume, procuring a portable resistivity meter capable of taking an accurate measurement over a very wide resistance range, developing the probe spacing technique to give the best possible data results, establishing the procedures to be used for subsurface contour mapping of electrical resistivity data, developing the procedures for preparing, fixing and evaluating the contamination spikes used for the gelatin evaluation and scaling up the small aquarium data to the large flume.

Phase two centered around the relationship between electrical resistance readings and identification of leachate contamination in both laboratory models. This relationship was developed by comparing the electrical resistance readings taken on a pure gelatin block to the electrical resistance readings taken on both a leachate gelatin block and a copper spiked leachate gelatin block.

Gelatin was chosen as the medium to conduct the relationship between resistance and contamination identification for three reasons. First, it can be prepared easily in small batches. Second, because it is liquid prior to cooling, any spikes under study can be mixed evenly throughout the gelatin. Third, its solid characteristics after cooling retain the spikes under study, and therefore, do not release the contamination into the laboratory model.

The gelatin holder was constructed of plexiglass because it is basically inert to electrical current. Small holes were drilled into the side faces of the holders to allow the current to pass through the gelatin, but not allow the gelatin to escape into the tank.

By eliminating soil variation, change in moisture content, lateral geologic variation, changes in the concentrations of conducting ions and man-made

obstructions, the project could focus on the relationship between electrical resistivity data and contamination identification.

LABORATORY MODEL DESCRIPTIONS

The initial resistivity data was taken in an aquarium with overall dimensions of 10 inches width, 10 inches depth, and 20 inches outside length.

A plastic liner was taped to all inside surfaces and the aquarium was filled to a depth of 9.3 inches with clean, dry Ottawa sand. The small tank was constructed of 1/4 inch glass sides and a 1/4 inch plastic bottom.

Water was added to the sand for a 10 percent saturation value and the sand was thoroughly mixed prior to each set of data points being taken. Similar data readings were taken for a 25 percent and 35 percent saturation value.

A more detailed description of the liner installation and sand moisture calculations can be found in the Methodology section.

There were six general relationships defined in the small tank evaluation. First, the effect of probe spacing on electrical resistance data. Second, the effect of probe depth on electrical resistance data. Third, collecting electrical resistance data from an insulated set of probes. Fourth, the effect of different rod lengths on the electrical resistance data. Fifth, the effect of current passing through

three different gelatin blocks and noting the changes in electrical resistance values. Last, the effect of current passing through paraffin-salt blocks and noting the resulting changes in electrical resistance values.

Once the aforementioned general relationships were established in the small tank, the rods and gelatin holders were scaled up to the large flume using the same sand depth to width ratio.

The overall dimensions of the large flume were 2 feet in width, 5 feet in depth, and 18 feet in length. Using the same sand depth to width ratio as the small tank, the depth of sand in the large flume was calculated to be 24.5 inches.

The large tank was prepared in the same steps as the small tank, however, considerable time and energy was spent installing the plastic liner and moving the total volume of sand into the large tank.

Because the relationships of probe depth, probe spacing, probe length, and insulation of the probe had been determined, these relationships were not of main concern in the large tank evaluation. The primary objective in the large tank was to compare the electrical resistance data obtained from passing current through three different gelatin blocks while holding certain probe relationships constant.

Due to the large standard deviation associated with the data collected, a greater number of data runs was required than was initially anticipated. Thirty data runs per gelatin block were performed in an attempt to keep the data within a high confidence interval.

A more detailed discussion of the individual steps of tank and sand preparation in the large flume can be found in the Methodology section of this report.

ELIMINATION OF VARIABLES AFFECTING RESISTIVITY DATA

Moisture

The most important variable encountered during this evaluation was moisture content. As the moisture content of the sand increased, the values of the electrical resistance data decreased. Water filled in the void spaces between the sand particles. Extremely high moisture contents, greater than 50 percent, had a tendency to "blank" or "zero out" the electrical resistance readings. It was felt that the easiest way to begin the data collection in the large tank was to choose a moisture content value of 10 percent and hold it constant throughout the gelatin evaluations in the large tank.

The real problem became moisture stratification in the large flume due to gravity pulling the water through the sand. At the beginning of each day's data collection, the top 18 inches of sand was hand mixed. The moisture content of the surface, 6 inch depth, 18 inch depth, and bottom (24.5 inch depth) for a randomly selected point revealed a varied range of pre-data moisture content values. The same four locations were analyzed for moisture content at the completion of each day's data collection. The results again revealed a

varied range of moisture content values for each randomly selected point.

The following table lists the upper and lower moisture content values by percentage found for each of the four data collection points, both pre-data collection and post-data collection, over the month long large flume evaluation.

Table 1 Summary of Moisture Ranges During Data Collection

	Pre-Data Moisture Content (%)		Post-Data Moisture Content (%)	
Depth	High	Low	High	Low
Surface	.361	.012	.116	.008
6"	.599	.022	.999	.019
18"	1.730	.014	1.783	.037
24"	15.152	4.658	15.486	1.313

A complete listing of the daily moisture content values for all data runs in the large tank can be found in the Appendix 2 of this thesis.

The moisture variability shown in the summary table above illustrates the difficulty in maintaining a constant moisture value during the data collection steps and the difficulty in reproducing the moisture stratification for consecutive data collection days.

The effects of moisture content could not be deleted as a variable for this study, especially in the large flume. Even though the amount of water entering the flume was calculated to produce a 10 percent

moisture value by volume for the entire flume, the bottom 6 inches of the large flume far exceeded the 10 percent moisture content while the upper layers were but a fraction of that amount.

Because the moisture stratification in the sand could not be eliminated, it was felt that a prescribed, reproducible procedure for preparing the sand prior to daily data collection would minimize the effect of moisture stratification. This procedure for sand preparation prior to daily data collection can be found in the Methodology section.

The lower 6 inches of the tank had moisture content values up to 100 times higher than the upper 18 inches of sand. This actually represented a shallow water table for the large flume and simulated field conditions.

It should also be noted that this lower 6 inch layer of sand turned anaerobic during the study. Although disinfection would have prevented the anaerobic conditions, it was felt that chemical treatment would add another variable to the study. The anaerobic conditions simulated actual anaerobic field conditions.

Sand Compaction

The results of the sand analysis is found on page III-11. As the sand particles were compressed closer together, the void spaces between the sand particles were reduced. As the void spaces were reduced, the resistance to electron flow through the sand was also reduced.

In the large flume study, mixing the sand by hand was found to be a more efficient and a less strenuous method of sand mixing than turning the upper 18 inches of sand with a hoe while leaning over the flume side wall. Hand mixing the sand added the variable that my body weight would compact isolated areas of sand, and therefore, produce isolated pockets of lowered resistance.

To resolve this problem, a small wooden board (23 inches long, 7 1/4 inches wide, and 3/4 inch thick) was placed at each station with the 23 inch length corresponding to the flume's 24 inch width. Standing on the board was an easy way to compact the sand to approximately 1/4 inch in depth across the entire length of the flume.

It is conceded that foot placement and changing body weight would vary the actual force applied to the sand surface. The use of this method of sand

Table 2
SAND ANALYSIS

Initial sample weight 500 grams.

Opening	Mesh	Sand Weight (grams)	Percent By Weight
600 um	30	9.1	1.8
300 um	50	378.3	75.7
150 um	100	93.5	18.7
75 um	200	15.0	3.0
Bottom Pan		3.9	0.8
Total		500.0 gms.	100.0%

Notes:

All weights were performed on a Ohaus Triple Beam Balance.

Sand analysis performed on a Soil Test Shaker, Serial Number 800905 for one hour.

Sieves were all USA Standard Testing Sieves from Soil Test, Inc.

compaction did not eliminate the variability of sand compaction completely, but it did reduce the variability to where it did not greatly affect the electrical resistance data obtained.

<u>Rods</u>

The rods were a source of considerable variability in the data. It was found in the initial aquarium studies that the small rods produced lower electrical resistivity values than the larger rods at all depths and all spacing configurations. This relationship was subsequently verified by initial studies in the large flume.

The depth of rod beneath the sand surface had a dramatic effect on the resistance value obtained. An increase in the distance between the two probes produced an increase in the electrical resistivity values. Also, insulating the rods produced a significant decrease in the electrical resistivity data obtained.

Each set of rods were cut from the same 1/8 inch diameter #2 rod. This ensured that the material of each rod was homogeneous and consistent to every other rod used.

The small rods were chosen for data collection in the large flume during the gelatin studies because the

resistance values obtained were in the middle scale ranges on the LCD Multimeter, which produced a more accurate data readout.

It was decided that a series of rod depths and spacings was the best way to clearly map the electrical resistance of the large flume. Therefore, three rod depths and four different rod spacings were chosen for data collection.

Early studies in the large flume revealed that the east wall of the flume always had higher electrical resistance results than either the center of the flume or the west wall of the flume. It was determined that three measurements would be required along the width of the flume, these points being the center and two quarter points.

A data run was then defined as three rod depths at each of three rod positions across the flume width and all nine of these points taken at four different rod spacings. In all, thirty-six data points constituted one data run. The rod spacings chosen were at 16 feet, 12 feet, 8 feet, and 4 feet apart, with the gelatin block in question being centered at these distances.

It was decided that whatever variability the rod depth and spacing had on the electrical resistance data collected, reproducing the data point depth and spacings for each gelatin block would eliminate these

factors from consideration in data collection. Therefore, whatever the variability these factors had, it was set equal for each set of data points taken.

The resistance studies on insulated rods provided an additional benefit. Originally, rod insulation was done to lower the electrical resistance readings to get the values on scale for the LCD Multimeter. By painting the rod with a thin coating of high gloss lacquer spray paint, the rod was given the insulation required which produced electrical resistance values in the proper meter ranges. By contrasting the colors of paint on the rods, the depth markings on the rods were easily distinguished for accurate, reproducible depth locations.

Meter

Another source of variability was the meter used to take data. The Micronta Multitester, Model 100A, originally used in the aquarium evaluations had acceptable accuracy at all meter scales, however, the data was subject to some drift as the reading time increased. There was some difficulty in reading the meter depending upon the scale being used.

A Micronta LCD Digital Multimeter, Model 22-191, was purchased to resolve problems with reading the meter, however, meter reading drifts were not

eliminated altogether. The meter drift characteristics are graphed in the Data section.

The graph of electrical resistance data versus time at randomly chosen points showed a sharp characteristic drop in the initial minute of data collection. For the first fifteen minutes, the electrical resistance values dropped slowly but steadily. This curve was found to hold constant for the large and small rods in both the large flume and small flume.

Because thirty-six data points were required per data run, it was realized that fifteen minutes per data point for meter stability would put unrealistic time characteristics on the data collection portion of this thesis. It was decided that all data points were to be collected one minute after adjusting the meter scale. This would not totally eliminate meter drift as a variable, but it would standardize it for all data points collected. A complete discussion of the data collection procedures is found in the Methodology section.

Gelatin Production

It was decided that the same recipe for gelatin be used throughout the study. Initial tests indicated that six grams of Knox gelatin would solidify 100 ml of

100 percent reverse osmosis (RO) water, while it required seven grams of Knox gelatin to solidify the leachate-reverse osmosis water combinations.

To standardize the recipe, seven grams of Knox gelatin was chosen for each 100 ml of liquid used to make the solid gelatin. The three standard recipes were 100 percent RO water, 75 percent RO water plus 25 percent landfill leachate, and 75 percent RO water plus 25 percent landfill leachate plus a 50 ppm copper sulfate spike.

Two gelatin block production methods were evaluated. First, pouring liquid gelatin into the gelatin holder and cooling it in the walk-in refrigerator in Room 714D. Second, hand molding solid gelatin into the gelatin holder. Pouring liquid gelatin was a faster production method; however, a large volume of gelatin was lost out the side holes drilled in the gelatin holders. The hand molding production method was chosen for this reason.

The variations in gelatin production were eliminated by following the same recipe and production method. It was also noted that a gelatin block held its good solid characteristics for approximately two weeks.

Wiring Resistance

In the small tank, the wire leads were 39.5 inches in length constructed of #18 copper wire and had a wire resistance of 1.2 Ohms. In the large tank, the wire leads were cut ten feet in length and constructed of #22 copper wire. The #22 copper wire was chosen because it was recommended for use with the breadboard assembly.

Even though the wire resistance of 1.3 Ohms was found in the ten foot leads, it was constant for all measurements taken in the large tank, therefore, eliminated as a variabililty in this study.

A more detailed evaluation of the circuits used in this study can be found in the Methodology section.

Breadboard

The breadboard was used to enable the meter to increase its scale capacity by adding an additional known resistance to the resistance data collected. This added resistance was recorded on the meter scale ranges.

Although it was not required for electrical resistance data taken on the gelatin blocks at a 10 percent moisture content, it was useful in determining the actual meter modification for extremely large study

areas with resistance values higher than the normal meter range.

Evaporation

Water evaporation from the flume was considered to be almost non-existent due to the gravitational pull on the water through the sand. The upper one-half inch of sand actually acted as a protective cover for the water in the tank.

Initial gelatin studies demonstrated that resistance readings decreased with an increase in moisture content.

After filling the tank with water to the required 10 percent moisture volume (111.5 liters), evaporation studies were initiated. The first day the evaporation rate was calculated at 0.05 ml per square inch of surface area per hour. Based on this calculation, an additional nine liters of water was added to the large flume.

By adding nine liters of water to the flume per day, it was obvious that the daily increase in moisture content would produce a daily change in resistance data. Therefore, all gelatin studies were run with the 121 liters of water in the large tank. Evaporation data taken throughout the course of this study can be found in Appendix 2.

METHODOLOGY

A defined set of procedures were used throughout this study. Each of the following procedures will be discussed in detail:

Protective Liner Installation and Repair

Movement of Sand into Laboratory Models

Sand Preparation and Compaction

Gelatin Production and Handling

Meter and Breadboard Circuit Designs

Data Recording Procedures

Design of Rod Holders

Design of Gelatin Holders

Design of Rods

Water Pump Design and Installation

A three-dimensional reference system was developed for both the small and large tanks. The x-direction was defined as the length of the tank in a horizontal direction, the y-direction was defined as the depth of the tank in a vertical direction, and the z-direction was defined as the width of the tank in a direction forward from the operator's position.

Protective Liner Installation and Repair

A 4 mm plastic liner similar to a landfill liner was installed along the interior surfaces of the small tank to prevent any electrical conductance from the tank. The liner was cut and taped to conform to the bottom of the tank. Sand was then added to hold the liner in place while the remaining sides were cut and taped.

The interior of the small tank was marked at a height of 9 1/4 inches along all sides of the protective liner. Dry, screened Ottawa sand was added to the small tank to this depth.

The large flume was swept clean prior to putting the liner in place. The liner was cut to length and fed in from the south (right) end of the tank to the north (left) end of the tank. Next, the liner was then cut and taped to fit the appropriate angles at the bottom and sides of the flume and set in place at the bottom edge by placing several pounds of dry sand along the bottom edge. The metal flume ends were quadruple lined with the 4 mm plastic to prevent any metal interference from the frame.

The inside liner was marked with a permanent marker to distinguish the height reference line for the sand surface. Station references were marked starting

with station one at 2 feet from the north (left) end of the flume and each station being 1 foot apart from the reference point. The last station number was 19 at the far south (right) end of the tank.

The final depth of sand in the flume was measured at 24.5 inches. The pump was placed at the far left end prior to adding sand. After the sand was added, the liner was cut over the top of the flume and taped to the metal frame supporting the flume with duct tape.

The liner was extended to the top of the tank and secured into place after the sand was added to the required level.

During the installation of the liner, one small two inch cut was found in the liner at station six east, approximately 8 inches from the bottom. It was taped with electrical tape prior to adding sand above that height. Cuts in the liner were also caused by the implements used to turn, mix, level and compact the sand. The cuts found were at or above the sand depth of 24.5 inches, and therefore, did not affect the overall outcome of the electrical resistance data taken. Sand did get between the liner and the outer flume walls at stations 4 east, 8 east, 13 west, 14 east, and 18 west; however, it showed no effect on the overall data taken.

Movement of Sand into Laboratory Models

The Ottawa sand was screened to remove large debris. It was noted that the 55 gallon drums storing the sand were unlined, and therefore, fine particles of rust were found throughout the sand. The rust particles were as small as the sand particles, so fine screening of the sand to remove the rust particles was impossible.

The screened, dry sand was then moved by hand in a small two gallon plastic bucket into the aquarium. The total volume of sand in the small tank was calculated to be 1.1 cubic feet of sand. This equates to approximately 182 pounds of sand with a density of 165.4 pounds per cubic feet. The large tank had a final sand volume of 73.6 cubic feet, and the weight of the sand screened and moved by hand was approximately 12,170 pounds.

In the large tank, Ottawa sand was screened into a plastic thirty gallon container and then transferred into the large tank with a two gallon bucket. Moving sand into the large flume took four days.

Sand Preparation and Compaction

Small Tank

Five hundred grams of clean, dry Ottawa sand was saturated with water to achieve a 100 percent saturation value. It required exactly 101 ml of water to achieve 100 percent saturation. Next, water was added to the tank to simulate the 10 percent, 25 percent, and 35 percent saturation values.

$$\frac{101 \text{ ml water}}{500 \text{ gms sand}} = \frac{X \text{ ml water}}{82{,}528.0 \text{ gms sand}} \quad \text{(Equation 4)}$$

Solving the above equation for X, the amount of water required to saturate the small tank to 100 percent saturation was 16.7 liter of water and a 10 percent moisture value required 1.7 liters of water.

Water was added to the sand and the sand was completely mixed to produce uniform saturation. Next, the sand was leveled with a small plastic shovel by lining the sand level up with the interior lines drawn on the inner plastic liner at a height of 9 1/4 inches. Then the sand was slightly compacted pressing the plastic shovel onto the sand surface by hand.

Distances were marked off at two inch intervals using a knife mark on the sand surface and rods were placed at these marks for data collection. As a set of

readings were completed, the top layers of sand were remixed, releveled and recompacted.

The gelatin blocks under study were buried at the center mark of the small tank after mixing and before sand leveling and compaction. The top of the gelatin holder was level with the surface of the sand and the gelatin block was centered from all four sides.

Large Tank

The inside of the flume was marked with station numbers 1 through 19, starting with station 1, approximately two feet from the left (north) wall of the tank and station 19 was at the far right (south) end of the flume.

A height line was drawn at 24.5 inches along all inside walls of the tank. This line was used to level the sand in the x and z directions.

The volume of water required for a 10 percent moisture content in the large tank was calculated in the same manner as the small tank. Based on a total dry sand weight of 12,170 pounds, a 10 percent saturation value required 111.5 liters of water.

The sand was mixed by hand with the operator inside the tank, laying down on a small protective cover. The top 18 inches of the sand was routinely turned over in this operation. The protective cover

was then taken out and the sand was leveled using a small, wooden board by locating the height line on the inside walls.

Next, the moisture data was taken. First, the protective cover was placed near a randomly chosen section. Then sand samples were taken at the surface, 6 inch depth, 18 inch depth, and tank bottom levels. The samples were collected in plastic weighing dishes for convenience. Samples were handled by the bottom of the plastic dish only and taken immediately to the Environmental Chemistry Lab (Room 712) where the percentage moisture evaluations were performed.

A crucible was weighed empty and the appropriate sample added. The crucible was then placed in the microwave oven at 100 percent power for five minutes and 0 percent power for twenty minutes. Next, the dried samples were then reweighed and the percentage moisture data calculated.

The gelatin block was then buried by digging out station ten with a hoe. The top of the gelatin block was placed level with the two height marks on the insides of the flume and centered in the z-direction between the two flume walls. A small level was placed on top of the gelatin holder to ensure it was buried level. Sand was slowly pulled back on top of the holder from both sides equally to ensure that the

weight of the wet sand did not damage the plexiglass gelatin holder.

Next, sand was releveled with the wooden board and compacted by positioning the board at each station and standing on the board. This applied equal compaction to the entire surface.

Next, the sand was smoothed using a small plexiglass shield to ensure all unleveled areas were taken out. Finally, a wooden two by four with two levels was placed along the surface of the sand to ensure that the tank was level in the x and z directions. Alterations in the sand surface were made at that time.

The rod holder was put at the appropriate stations and the rods hooked up according to the steps listed in the Data Recording Procedure section. After a set of thirty-six readings had been taken, the reading positions were tapped with the hoe to collapse the existing hole and the surface was then resmoothed with the plexiglass shield.

At the completion of all daily runs, moisture data was taken at the surface, 6 inch, 18 inch, and bottom depths at the same location as taken at the start of the day. The meter was evaluated with four resistors of known value to test each scale of the meter at the end of each day.

Gelatin Production and Handling

Gelatin Recipe

The solid gelatin used was Knox commercial gelatin. Various recipes were tested to determine the optimum amount of solid gelatin requied to gel the leachate/water, copper leachate/water and water solutions to be tested.

The leachate used in the gelatin production came from lysimeter #22. The characteristics of the lysimeter can be found on page III-28.

One hundred ml of each test solution was evaluated for gelling time, consistency of gelatin and duration of gelatin phase. The results showed that leachate solutions required more solid gelatin to be added to the solution to produce a hard gelatin mass in a reasonable amount of time. The results are found on page III-28. Seven grams of solid gelatin was required per 100 ml of solution to produce the gelatin mold desired.

Techniques

The gelatin was produced in small batches for better control of gelling and molding applications. A 1,000 ml beaker was used to hold the appropriate volume of liquid with the required proportion of solid gelatin mixed into the liquid. The mixture was then heated

Table 3
LEACHATE CHARACTERISTICS LYSIMETER #22

Characteristic	Value (mg/l)
pH	5.70 units
Alkalinity	6530
Volatile Acids	6737
COD	16,200
TOC	5240
TKN	188
PO_4	8.7
TS	10,400
VS	5090
Cd	0.005
Cr	0.048
Cu	0.028
Pb	0.160
Ni	0.22
Zn	0.10

Table 4
GELATIN SOLIDIFICATION DATA

Grams Gelatin	ml Super Q	Time to Gel Room Temp	Time to Gel Cooled
5	10	Instant	NR
5	20	Instant	NR
5	25	Instant	NR
5	30	Instant	NR
5	35	32 min.	NR
5	40	40 min.	NR
5	45	45 min.	NR
5	50	42 min.	NR
5	60	55 min.	NR
5	75	1 hr. 10 min.	NR
5	100	2 hrs. 12 min.	1 hr. 15 min.

Grams Gelatin	ml Leachate	Time to Gel Room Temp	Time to Gel Cooled
5	100	2 hrs. 10 min.	1 hr. 35 min.
6	100	1 hr. 38 min.	47 min.

Grams Gelatin	ml Copper Leachate	Time to Gel Room Temp	Time to Gel Cooled
5	100	2 hrs. 10 min.	1 hr. 35 min.
6	100	1 hr. 55 min.	47 min.

Note: NR means not required

over a Bunsen Burner until the solid gelatin was completely dissolved.

The beaker was then labeled, covered, taped, and taken into the cold storage room (Room #714D) for storage. Once the mixture had reached a solid state, it was hand molded into the gelatin holder.

The side faces of the holder were covered with plexiglass sheets and clamped using several metal all-purpose clamps. The purpose of clamping plexiglass sheets over the holder face plates was to prevent the gelatin mixture from coming out the holes in the gelatin holder while being stored.

Gelatin was added until a line was reached at the top of the holder. Although the original line was arbitrarily drawn at 1/4 inch from the top for the small holder and scaled to 3/4 inch from the top for the large holder, each size holder had a line at the same corresponding height to ensure that approximately the same volume of gelatin was in each holder. The volume contained in each holder is shown on page III-30.

Table 5

Holder	Volume Contained By The Holder (ml)
Small Gelatin	172.3
Small Leachate	174.3
Small Copper Leachate	170.5
Large Gelatin	3,227.7
Large Leachate	3,144.5
Large Copper Leachate	3,106.7

The volume of gelatin contained in the holders varied by 2 percent for the small holders and by 4 percent for the large holders.

During some large tank gelatin evaluations, gelatin was lost from the holders. This gelatin loss was recorded daily and gelatin was replaced in the plexiglass holder to slightly above the line drawn on the holder at the end of each day.

Meter and Breadboard Circuit Designs

For recording data in the small tank, the meter circuit was hooked up as shown below:

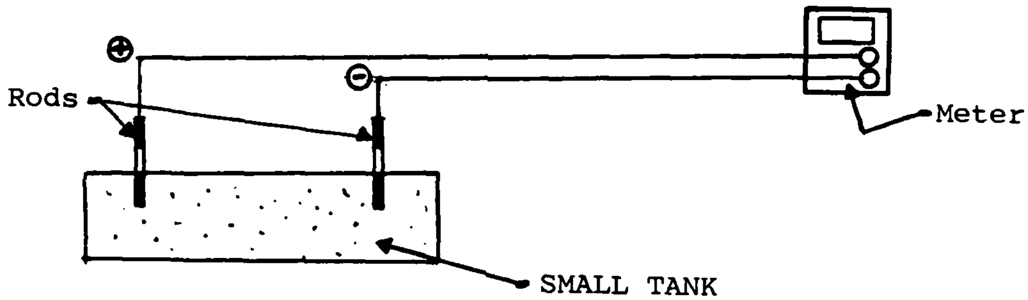


Figure 4

The leads for this arrangement were 39.5 inches long and composed of #18 copper wire with a measured resistance of 1.2 Ohms in each lead.

For recording data in the large tank, the meter circuit was hooked up exactly as for the small tank except the leads were 10 feet long and composed of #22 wire with a measured resistance of 1.3 Ohms in each lead.

The breadboard was designed to add additional resistance to the circuit, and therefore, increase the scale capacity of the meter. The typical circuit for the breadboard is shown on page III-32.

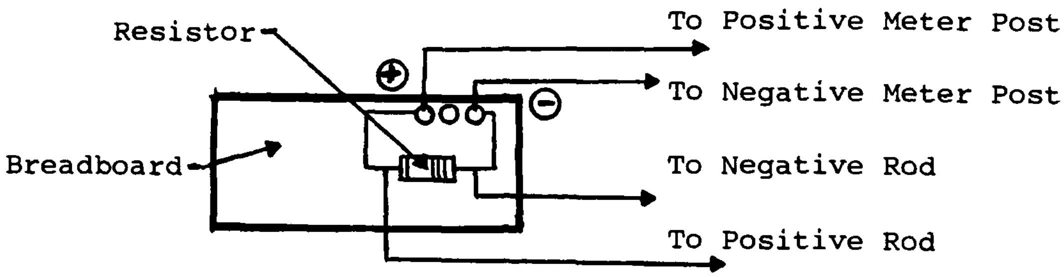


Figure 5

Although the data for the large flume was collected without the use of the breadboard, the additional meter range provided by the breadboard would have proved invaluable if the resistance readings had exceeded the meter's capacity. The breadboard would have provided the LCD Meter with a known resistance, and therefore, would have eliminated the need for a second, higher range meter which would have added another variable to the data collection.

Data Recording Procedures

First, the rod holder was positioned and leveled at the left (north) side at station #2. Next, the rod was put through the top (east) hole and worked through the bottom two plexiglass slats. The rod was pushed into the sand to the one-third depth marking. Next, the alligator clip was attached to the top of the rod and pulled up slightly to ensure a good grip on the rod.

The right (south) side rod holder was positioned and leveled at station #18, with the rod depth and alligator clip procedures remaining as stated above.

The operator returned to the meter position, station #10, and checked the meter scale. The meter scale was reduced until a flashing "1000" appeared on the meter screen. The meter scale knob was then moved up one scale. This ensured that all the data readings were taken on the lowest possible scale.

The stopwatch was then turned on and the meter value and scale were recorded at one minute. If the meter value changed at one minute, the higher of the two values was recorded. This occurred infrequently on the 200 scale and involved resistance values in the tenths place.

The stopwatch was then reset to zero. The operator then walked to the left rod holder and pushed the rod

into the sand to the next colored band. This depth represented the one-half depth position.

The operator repeated the above procedures for the right rod holder and returned to the meter position. The scale was checked as before and the stopwatch started. Again, the value and scale were recorded at one minute.

The stopwatch was reset to zero and the operator walked to the left position and pushed the rod into the sand to the next colored band. This represented the two-thirds depth position.

The operator then walked to the right position, pushed that rod to the two-thirds depth position and returned to the meter position. Data recording was again accomplished at one minute as stated before.

After the two-third depth value was recorded and the stopwatch reset to zero, the operator walked to the left position, unclipped the alligator clip, and removed the rod from the rod holder.

The rod was then inserted into the top center hole and worked through the bottom two slats in the rod holder. This rod was pushed into the sand to the one-third depth marking. The rod at the right position was removed and placed in the center hole position in the same manner.

Data were collected for the center hole position at the one-third, one-half and two-third depths with the same procedures as outlined earlier. These nine data points represented data collection at one horizontal distance. After recording the nine data points at this horizontal distance, the meter was zeroed.

The rod holders were moved to stations #4 and #16 and the nine data points were collected at this horizontal distance. Similar data points were collected for positions #6 and #14 and for positions #8 and #12. In all, thirty-six data points were collected per data run.

Design of Rod Holders

The purpose of the rod holder was to ensure that the rod was placed perpendicular to the sand surface, so that the rod depth values of one-third, one-half, and two-thirds were reproducible for each station.

The rod holders were not required for the small tank, because placing the rods perpendicular to the sand surface in the small tank was simply a matter of lining up the rod in two different directions. The rods were sighted in the x and z direction and placed perpendicular to the sand surface.

The rod holders were required for the large tank, because pushing the rods perpendicular to the sand surface was complicated by the fact that the operator must lean over the wall of the tank and push the rod down and away. There were no reference points that could be established in two directions, so the rod holder was designed to accomplish a reference system for the rod in the x and z directions.

The design of the rod holder as shown on page III-37 allowed either the large rod or small rod to be tested. The rod holder was constructed out of plexiglass for three reasons. First, the plexiglass was strong, yet flexible when placed in two inch wide strips. Second, being clear, it was very easy to look

down on the operation and note the color change (black to white or vice versa) on the rods as they were pushed into the sand. Third, plexiglass is relatively non-conductive and did not interfere with the resistance data being taken.

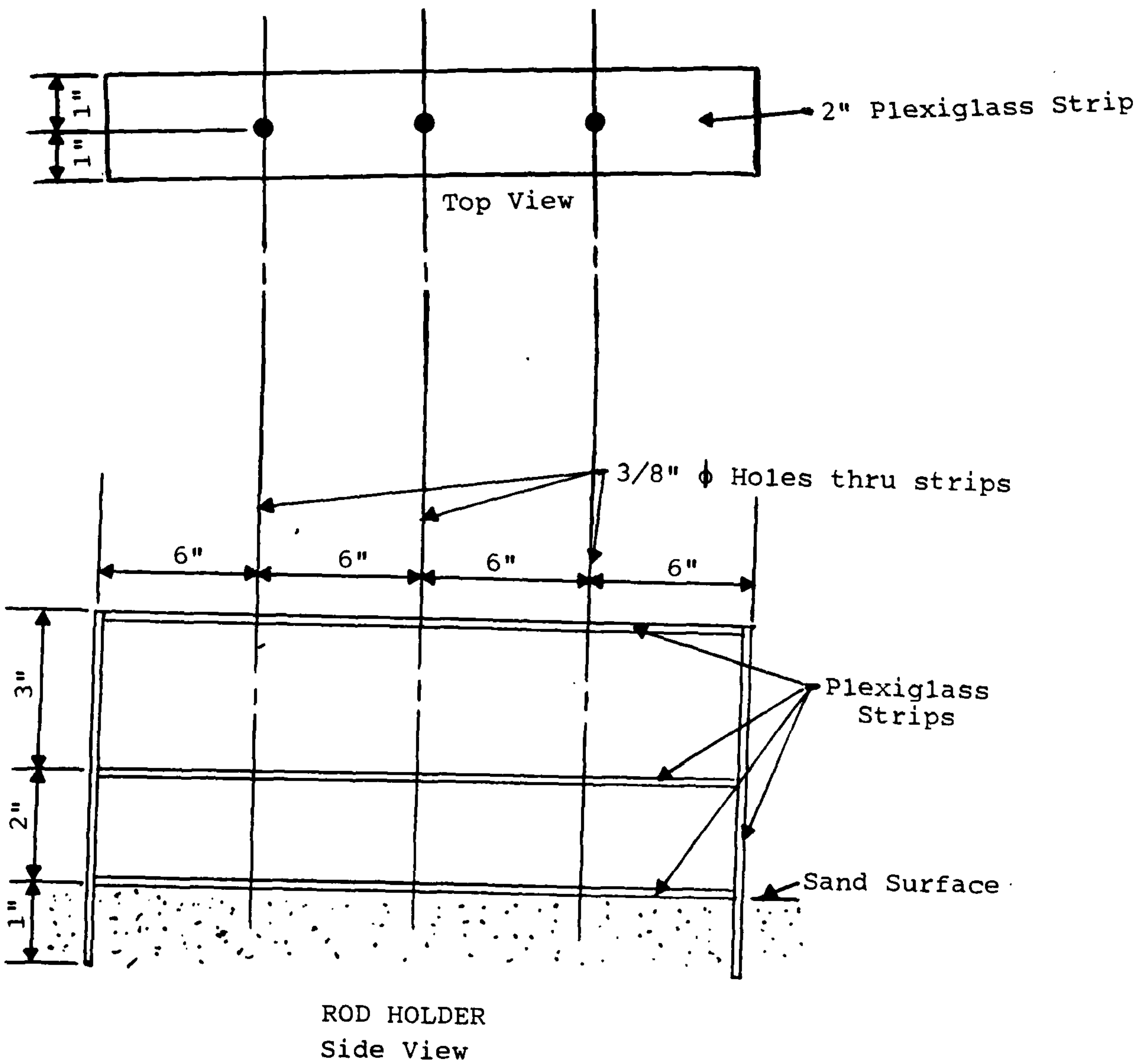


Figure 6

Design of Gelatin Holders

The purpose of the gelatin holder was to hold the gelatin under study, and be electrically non-conductive. Holes were drilled in the side faces of the holders to allow the current to pass through the gelatin block under study. One-eighth inch in diameter holes were drilled in the side plates of the small gelatin holder. The hole pattern selected for the small holder was 4 rows of 4 holes and 3 rows of 3 holes for a total of 25 holes.

It was decided that a thin, rectangular shape that would effectively block the electrical impulse between electrodes was required. The final dimensions of the small holder were 8 inches long, 6 inches high and having a thickness of 1/4 inches.

The dimensions of the large holder were calculated using the same height to width ratio as the sand height in the small tank compared to the width of the small tank. The final dimensions of the large holder were 18.9 inches long, 14.4 inches high and having a thickness of 0.6 inches. A diagram of both the small and large gelatin holders can be found on page III-39.

The face pieces and holder slats were cut from 0.08 inch plexiglass to the aforementioned dimensions, by first scoring the plexiglass and then breaking the cut piece from the large sheet. Holes were drilled

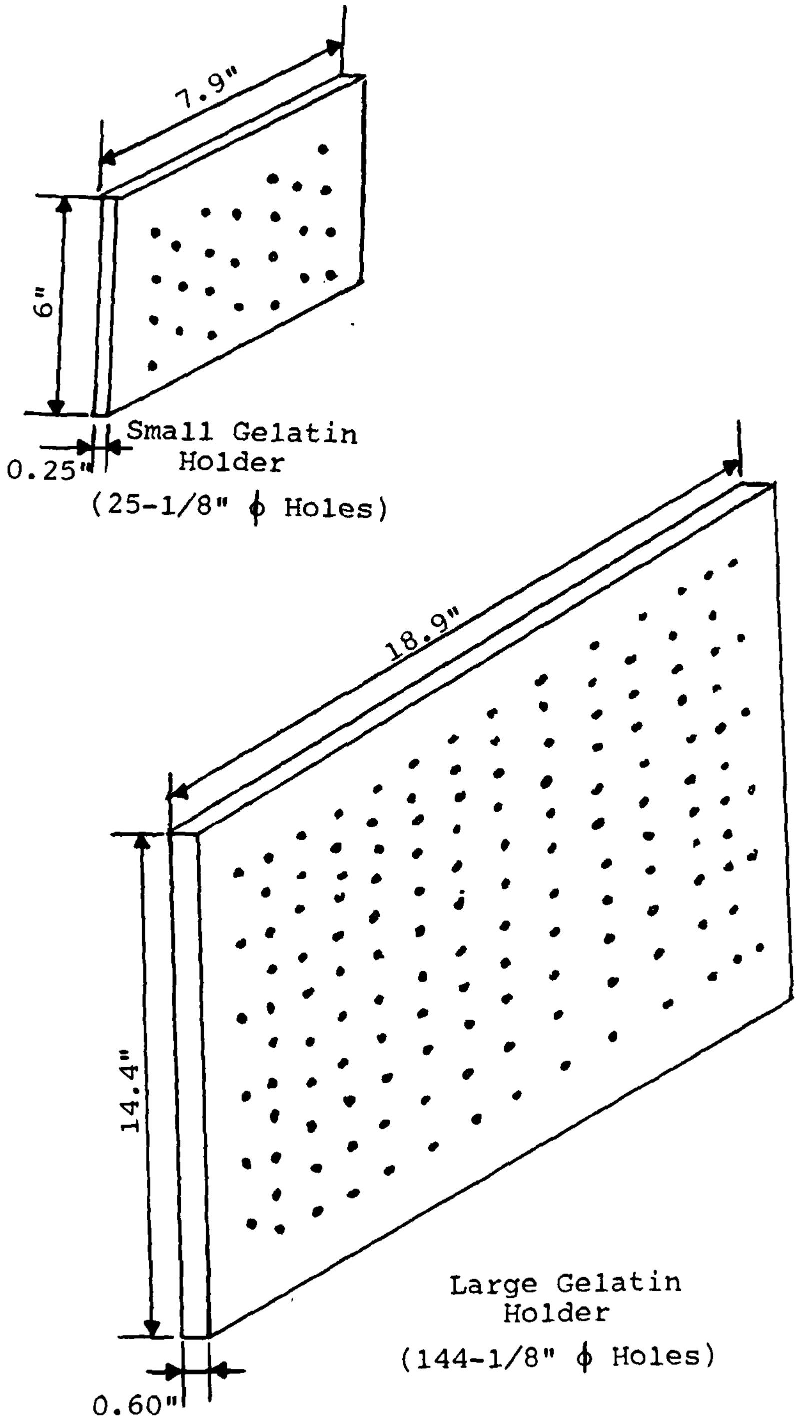

7.9"
6"
0.25"
Small Gelatin Holder
(25-1/8" ϕ Holes)
18.9"
14.4"
0.60"
Large Gelatin Holder
(144-1/8" ϕ Holes)

Figure 7

using an one-eighth plexiglass drill bit to the chosen pattern design. The hole pattern selected for the large holder was 6 rows of 14 holes and 5 rows of 12 holes for 144 total holes.

Gelatin holders were assembled by taping the plexiglass bottom slat to the bottom edge of the plexiglass holder face with masking tape while holding the edge using a wooden two by four. Once the edge was taped, the seam was glued using an electric glue gun and hot melt glue sticks. Each of the two side slats were glued by the same procedure.

The other holder face was placed on top of the open holder and taped into place. This face was then glued on all three seams. The holder was then visually inspected for gaps and reglued accordingly. Finally, Dow Corning 100 percent silicon rubber sealant was placed around the outside of the holder and the edges taped with duct tape.

Additional slats (one for the small holder and two for the large holder) were placed inside the plexiglass holder and taped into place. These slats were designed to give the holder more support once the holder was filled with gelatin. During storage the metal clamps were placed at these supports and did not deform the shape of the gelatin holder. After the gelatin had

set, duct tape was put over the top of the gelatin holder to enclose the gelatin.

Design of Rods

For the initial test runs taken, a #2 steel reinforcing rod was chosen because of its easy access. The ASTM properties of this rod can be found on page III-43.

Two rods were cut 6 inches in length and initial depth electrical resistivity readings were taken in the small tank. The 6 inch rod was marked at 1 inch intervals with a permanent marker and studied for depth resistivity readings. Next, two 3 inch rods were cut and marked at the 1 inch and 2 inch intervals and evaluated for depth resistivity readings.

The 6 inch rod was then taped with electrical tape and studied for variance in depth electrical resistivity properties. Next, the 6 inch rod was painted and studied for depth electrical resistance properties in the small tank. It was decided to use a painted rod for the large tank due to the good color contrast of alternating black and white sections of paint. A 3 inch rod and 6 inch rod were painted as shown on page III-43 at the one-third, one-half, and two-thirds depth points.

The rods used in the large flume were sized by using the same depth to height ratio as the sand height in the small tank to the height of the small tank. Two

Table 6

SPECIFICATIONS

Concrete. *See* Non-metallic Materials, Section 13.

Reinforcement. Expanded metal, triangular mesh, or wire fabric is often employed in slabs of moderate span, and in walls and partitions. The great bulk of reinforcement used, however, is in the form of bars, either plain or deformed, the deformations aiding the bond between the steel and concrete. Table 1 gives the areas, weights, and perimeters of standard reinforcing bars.

Table 1. Standard A305 Reinforcing Bars

Size											
	Inches	1/4	3/8	1/2	5/8	3/4	7/8	1			
	Number	2	3	4	5	6	7	8	9	10	11
Diameter, in.		0.250	0.375	0.500	0.625	0.750	0.875	1.000	1.128	1.270	1.410
Area, sq in.		.05	0.11	0.20	0.31	0.44	0.60	0.79	1 00	1.27	1.56
Weight per ft, lb		.167	0.376	0.668	1.043	1.502	2.044	2.670	3.400	4.303	5.313
Perimeter, in.		786	1.178	1.571	1.963	2.356	2.749	3.142	3 544	3.990	4.430

The bar numbers are based on the number of 1/8 in. increments included in the nominal diameter of the bar.

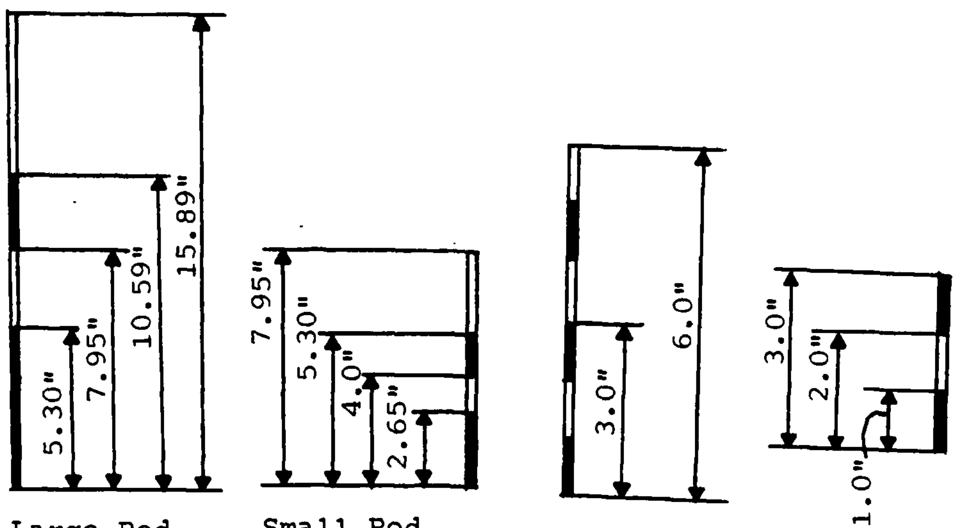
Bar number 2 is available in plain rounds only. Bars numbered 9, 10 and 11 are round and equivalent in weight and nominal cross-sectional area to the old type 1 in., 1 1/8 in., and 1 1/4 in. square bars.

Deformations on deformed bars shall conform to "Standard Specifications for Minimum Requirements for the Deformations of Deformed Bars for Concrete Reinforcement" (*A.S.T.M. Designation:* A305—50T).

The so-called "intermediate grade" of billet steel (see A.S.T.M. Specifications) can generally be used for all purposes where reinforcement is required. Rail steel, rerolled to rods and bars (see A.S.T.M. Specifications for Rail-steel Concrete Reinforcement Bars), is a satisfactory reinforcement in designs that do not require bending of the rods. Wire reinforcement shall conform to the A.S.T.M. Standard Specifications for Cold-drawn Steel Wire for Concrete Reinforcement.

Steel reinforcement should be stored on racks, but need not be protected from the weather unless kept for long periods. A light coating of red ru t does not injure the bond between steel and concrete, but heavy scale should be removed by wire brushing.

From Handbook of Engineering Fundamentals by Ovid W. Eshbach and Mort Souders, Copyright 1975 by John Wiley & Sons, Inc., p. 549.



Large Rod   Small Rod

LARGE TANK STUDY

Large Rod   Small Rod

SMALL TANK STUDY

Figure 8

rods 15.9 inches long and two rods 8 inches long were cut and evaluated for depth and spacing properties. The rods for the large flume were painted in the same alternating black and white pattern as stated before.

All four rods were tested in the large flume using three different gelatin molds. The smaller 8 inch rod was then chosen for the remainder of the electrical resistance evaluation in the flume. Rods were repainted after the end of each workday because handling of the rods started scratching the paint coating.

Water Pump Design and Installation

The original purpose of the pump was to evacuate the water in the large flume at various intervals throughout the study. A 20-gallon polyethylene drum was chosen for containing the pump. The top of the drum was cut off and the container thoroughly cleaned and rinsed.

A 2 1/2 inch diameter hole was cut in the bottom side of the container and a 8 inch long, 2 3/8 inch diameter polyvinyl stub pipe was placed through the hole, extending 6 inches past the container wall.

This stub pipe had been previously drilled with numerous 1/8 inch diameter holes and filled with glass wool. The stub pipe was designed to act as a drainage siphon with the glass wool packing filtering out any sand pulled into the pipe.

A small horsepower sump pump was chosen to pump out the flume and was placed in the pump container. The pump was rated at 205 gallons per hour at a height of one foot. It was found, however, that a 10 percent moisture content of the sand did not permit the sump pump to be sitting in water, and therefore, it could not be used to evacuate water from the flume. Even priming the sump pump did not activate it for such a small moisture content value.

A wooden brace was placed on the outside edge of the pump container to keep the sand at station one from covering the pump container. The wooden brace also kept the sand at station one at the required height of 24.5 inches.

CHAPTER 4 - DATA AND DATA EVALUATION

Small Tank

Probe Depth

First, the depth at which the rod was submerged into the sand showed an important relationship used for subsurface mapping. As the summary table on page IV-2 illustrates the resistance readings for a completely submerged rod were much lower than the resistance readings for a rod only partially submerged. This relationship can be seen in the Mean Resistance Value graphs on page IV-3 and the resistivity summary graphs on page IV-4 for both the small (3 inch) metal rods and the large (6 inch) metal rods.

Two reasons can be given for a lower resistance value at lower depths in the small laboratory model. First, the volume of sand conducting the electricity is related to the area of rod in contact with the sand. As the rods go deeper into the sand, the conducting sand volume is increased and a corresponding drop in resistance is seen. Second, as the rod goes deeper into the sand, more rod is in contact with the sand particles and the water coating the sand particles.

SUMMARY OF INITIAL DEPTH AND SPACING DATA
SMALL TANK
3" ROD

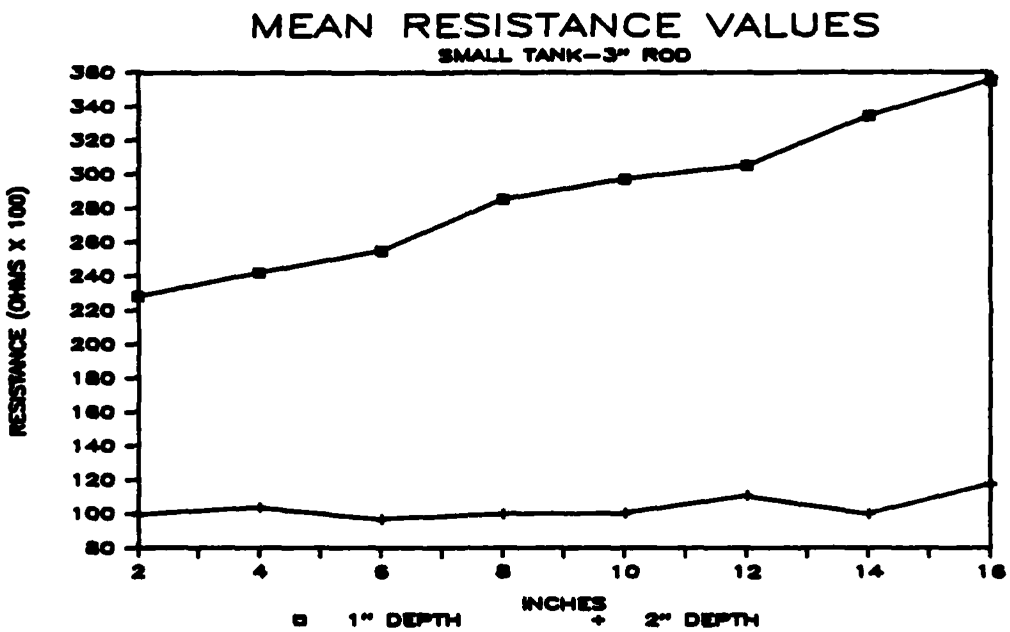
RESISTANCE (OHMS X 100)

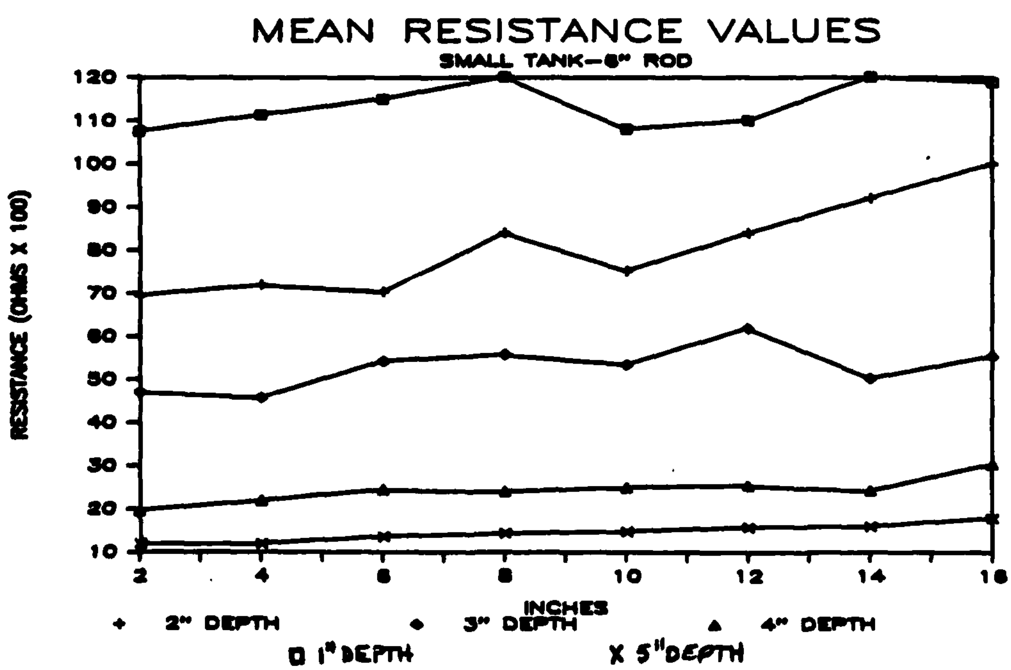
DISTANCE APART (INCHES)	DEPTH 1"	2"
16	355.0	117.7
14	334.0	100.0
12	305.0	111.0
10	297.0	100.5
8	285.0	99.8
6	255.0	96.8
4	242.0	103.8
2	228.0	99.3

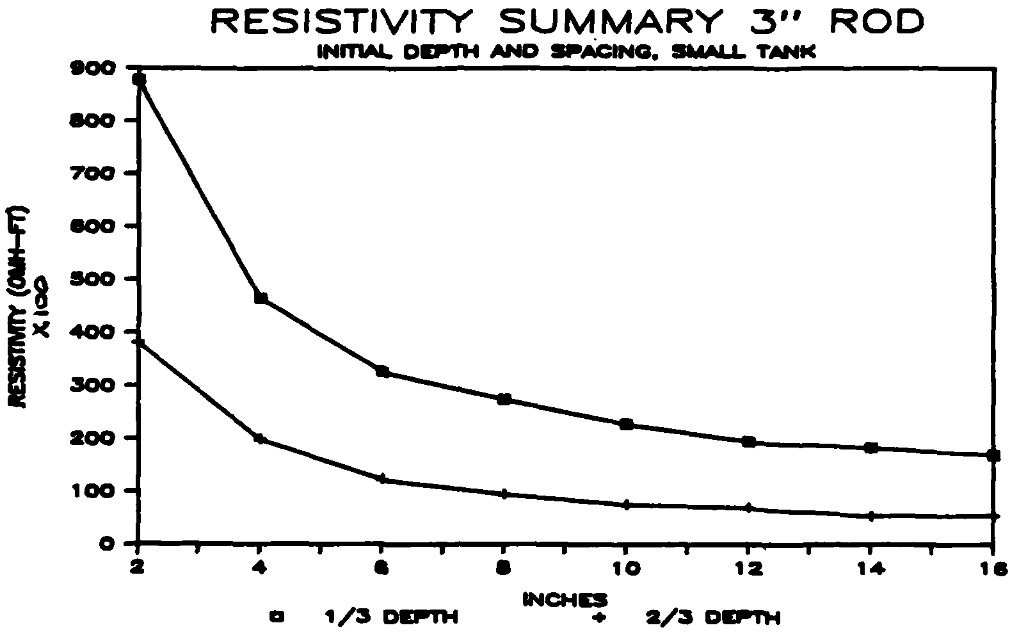
6" ROD

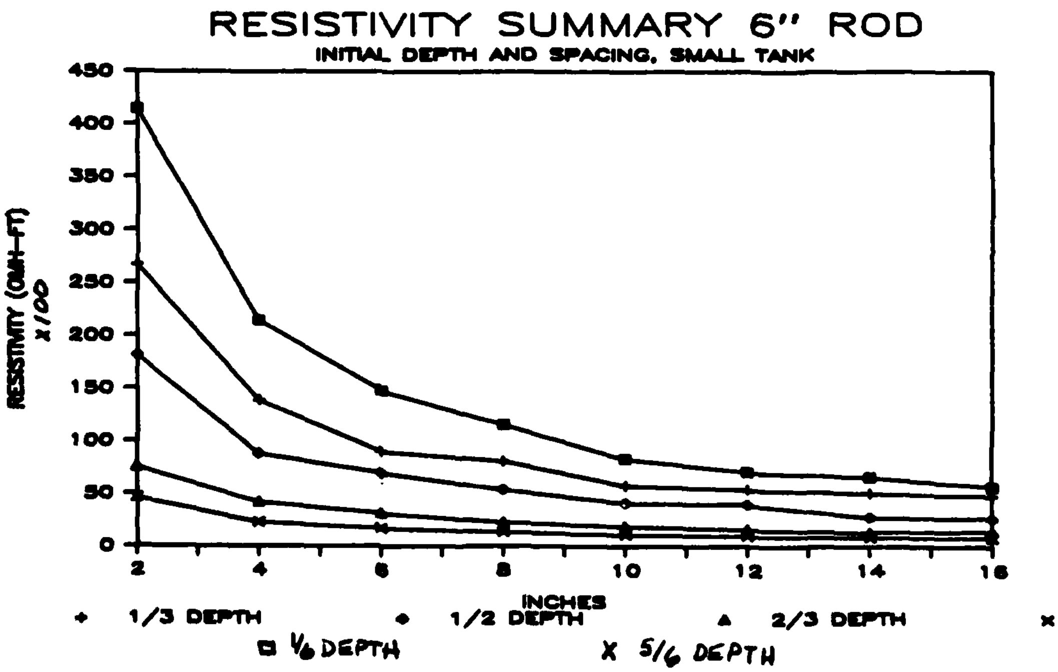
RESISTANCE (OHMS X 100)

DISTANCE APART (INCHES)	DEPTH 1"	2"	3"	4"	5"
16	118.8	100.0	55.5	30.5	17.9
14	120.0	92.0	50.3	24.3	16
12	110.0	84.0	62.0	25.5	15.8
10	108.0	75.2	53.5	25	14.8
8	120.0	84.0	55.8	24	14.3
6	115.0	70.4	54.3	24.5	13.6
4	111.3	72.0	45.8	21.9	11.9
2	107.5	69.4	47.0	19.6	12


MEAN RESISTANCE VALUES
SMALL TANK—3" ROD
RESISTANCE (OHMS X 100)
INCHES
1" DEPTH
2" DEPTH


MEAN RESISTANCE VALUES
SMALL TANK—6" ROD
RESISTANCE (OHMS X 100)
INCHES
2" DEPTH
3" DEPTH
4" DEPTH
1" DEPTH
X 5" DEPTH


RESISTIVITY SUMMARY 3" ROD
INITIAL DEPTH AND SPACING, SMALL TANK
RESISTIVITY (OMH-FT) X100
0
100
200
300
400
500
600
700
800
900
2
4
6
8
10
12
14
16
INCHES
1/3 DEPTH
2/3 DEPTH


RESISTIVITY SUMMARY 6" ROD
INITIAL DEPTH AND SPACING, SMALL TANK
RESISTIVITY (OMH-FT) X100
0
50
100
150
200
250
300
350
400
450
2
4
6
8
10
12
14
16
INCHES
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH
1/6 DEPTH
X 5/6 DEPTH

This results in a greater conductance capability at deeper depths, and therefore, a lower associated resistance value.

Rod Spacing

The distance between the two probes under evaluation, produced another definable relationship. As the distance between the probes increased the resistance value also increased. The current must pass through a greater volume of sand as the probes are moved apart which means an increased resistance to electron movement. The summary table on page IV-2 and graphs on pages IV-3 and IV-4 illustrate this relationship.

This decreasing resistance relationship for increased spacing also held for the 6 inch rod when tested at oversaturated conditions. A complete listing of the rod depth and spacing data is found in Appendix 1, pages A1-1 through A1-6.

Different Rod Lengths

A set of 3 inch rods and a set of 6 inch rods were compared for differences in resistance values. By keeping the rod depth and spacings constant for both sets of rods evaluated, it was noted that most

resistance values for the large rods were lower than the resistance values for the small rods.

The summary table on page IV-2 and graphs on pages IV-3 and IV-4 illustrate that the large rod submerged the same depth as the small rod will produce a lower resistance value. This can be explained due to the increased volume of metal through which the current passes in the large rod. The metal rod is an excellent conductor and the increased volume present means better electrical conductance. Increased conductance means a lower overall resistance value.

The evaluation in the small tank was not extended to prove or disprove this relationship. It was decided that all gelatin studies would be accomplished with one set of rods and that the choice of rod length was dependant upon the desired output scale on the LCD Multimeter instead of a resistance relationship derived from rod length.

Taped Rods

Both the 3 inch and 6 inch rod sets were taped with electrical tape and evaluated for resistance data at various depths, rod spacings and taping patterns. The results are summarized on pages IV-7 and IV-8.

The 3 inch taped rod showed a general decrease in resistance with a decrease in spacing. Further, the

SUMMARY OF RESISTANCE DATA FOR TAPED RODS

6"ROD,2"DEEP,2"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	7
12	3.6
8	3.5
4	3.4

6"ROD,4"DEEP,2"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	0.9
12	1.2
8	1.6
4	2.1

6"ROD,4"DEEP,4"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	1.5
12	2.2
8	1.5
4	1.3

6"ROD,1"DEEP,1"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	13.8
12	6.4
8	7.3
4	6.5

6"ROD,2"DEEP'4"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	12.7
12	13.2
8	17.4
4	18.5

6"ROD,2"DEEP,1"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	3.2
12	3.3
8	3.2
4	3.9

SUMMARY OF RESISTANCE DATA FOR TAPED RODS

3"ROD,1"DEEP,2"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	9
12	5.3
8	6.2
4	6.3

3"ROD,2"DEEP,2"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	5.1
12	2.6
8	2.8
4	3.8

3"ROD,2"DEEP,2"TAPED,LOOSE

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	4.8
12	3.8
8	3.5
4	3.4

3"ROD,2"DEEP,2"TAPED,COMPACTED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	2.3
12	3.2
8	2
4	3.5

more taped surface area of rod, the lower the resistance values. This result was most pronounced at the 16 inch spacing. Lastly, the compacted sand evaluation revealed a much lower resistance value at the 16 inch spacing than the loose sand configuration. This relationship was less pronounced as the probes were moved closer together, but a general decrease in resistance was noted as the sand was heavily compacted.

The 6 inch taped rod did not show a definable resistance to spacing pattern, however, as more surface area of the rod was taped the resistance values decreased accordingly.

The taped portion of the rod insulated the rod from contact with the sand particles and conducting water moisture, and therefore, lowered resistance values. This relationship also provides evidence that the resistance data is more dependant upon the area of rod in contact with the sand than the overall volume of metal contained per rod. Further as the sand was compacted, the void spaces between the sand particles were reduced and resulted in an overall decrease in resistance to electron movement.

Paraffin Block Studies

Paraffin blocks (1/4 inch by 4 5/8 inch by 3 3/4 inch) were evaluated in the small tank to develop a

relationship between resistance data and objects buried in the sand. Paraffin was chosen in this evaluation because it was felt that it would effectively block the current as it passed through the sand. A summary of the paraffin evaluations is found on pages A1-12 and A1-13 and the complete data results in Appendix 1, pages A1-12 through A1-16.

Six overall evaluations were performed. First, both the large and small rod sets were used to evaluate the paraffin block buried at the center of the tank and with the paraffin block positioned 4 inches from one end of the tank. Next, the two rod sets were used to evaluate a paraffin block with twelve 1/4 inch holes drilled through it, buried both at the center of the tank and 4 inches from one end of the small tank. Third, a paraffin block was spiked with salt and evaluated both centered and off-centered with both rod sets. Fourth, a paraffin-salt block with holes was evaluated both centered and off-centered with both rod sets. Fifth, two salt blocks were evaluated both centered and off-centered for two rod sets. Finally, two paraffin salt blocks with holes were evaluated both centered and off-centered for both rod sets.

Single paraffin and paraffin salt blocks evaluated with holes showed higher resistance values than the single paraffin blocks with no holes. The differences

in resistance values between two blocks with holes compared to two blocks without holes was less pronounced. The addition of holes in the block should have allowed the current to pass more easily through the block and would have resulted in lower resistance values, not higher values as was recorded. It is reasoned that the variation between paraffin blocks with holes and those blocks without holes is so small that the change is lost in the standard deviation of data collected.

The resistance data pattern for centered paraffin blocks was similar to the pattern for uncentered paraffin blocks. Both patterns showed an increased resistance for increased probe space and a decreased resistance for increased probe depth as expected.

The similarity of these two data patterns suggests that resistance values are more dependant upon distance between probes than the location of the buried object between the two probes. This comparison between data patterns was not evaluated further during this project.

The paraffin-salt blocks produced lower resistance values when compared to the paraffin blocks, for both the small and large rod sets. Data for paraffin blocks is summarized on pages IV-12 and IV -13. This lower resistance value was due to the addition of the salt which increased the number of conducting ions present.

PARAFFIN-SALT BLOCK STUDIES SMALL TANK
3" ROD

SALT BLOCK CENTERED
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
16	1.9	1.2
12	1	0.6
8	0.7	0.8
4	0.6	0.7

SALT BLOCK CENTERED W/ HOLES
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
16	2.2	1.4
12	1.1	0.8
8	1.3	0.9
4	1.2	0.9

TWO SALT BLOCKS CENTERED
RESISTANCE (X10K)

DIST APART (IN)	DEPTH 1"	2"
16	1.5	1.6
12	0.9	1.2
8	1.1	1.4
4	0.8	1.2

TWO SALT BLOCKS CENTERED W/ HOLES
RESISTANCE (X10K)

DIST APART (IN)	DEPTH 1"	2"
16	1	1.4
12	0.7	1
8	1	1.1
4	0.6	0.8

SALT BLOCK 4" LEFT WALL
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
2	2.6	1.7
4	2.2	1.5
6	2.2	1.5
8	2.1	1.4
10	2.1	1.4

TWO SALT BLOCKS 4" LEFT HOLES
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
2	1.6	2.3
4	1.3	2.2
6	1.3	2
8	1.3	2
10	1.2	2

TWO SALT BLOCKS WITH HOLES 4" LEFT WALL
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
2	1.5	1.9
4	1.3	1.5
6	1.3	1.6
8	1.5	1.5
10	1.4	1.3

PARRIFIN-SALT BLOCK STUDIES SMALL TANK
6" ROD

SALT BLOCK CENTERED

DIST APART (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
16	1.2	0.7	0.4
12	0.6	0.5	0.4
8	0.7	0.6	0.4
4	1.1	0.6	0.3

SALT BLOCK WITH HOLES CENTERED

DIST APAR (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
16	1.4	0.9	0.6
12	0.8	0.5	0.4
8	0.9	0.7	0.6
4	0.9	0.6	0.5

TWO SALT BLOCKS CENTERED

DIST APART (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
16	0.9	0.6	0.3
12	0.9	0.6	0.5
8	1	0.7	0.5
4	1	0.6	0.5

TWO SALT BLOCKS WITH HOLES CENTERED

DIST APAR (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
16	1.2	0.8	0.5
12	0.8	0.5	0.3
8	0.8	0.6	0.6
4	0.6	0.4	0.3

SALT BLOCK 4" LEFT WALL

DIST APART (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
2	2.2	1.3	0.8
4	1.8	1.2	1
6	1.8	1.1	0.8
8	1.8	1.1	0.8
10	1.7	1	0.6

TWO SALT BLOCKS 4" LEFT WALL

DIST APAR (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
2	1.9	1.2	0.8
4	1.7	1	0.8
6	1.6	1	0.8
8	1.6	1	0.7
10	1.5	0.8	0.6

TWO SALT BLOCKS 4" LEFT WALL W/ HOLES

DIST APART (IN)	RESISTANCE (X10K) DEPTH 2"	3"	4"
2	1.2	0.9	0.6
4	1	0.8	0.5
6	1	0.7	0.5
8	1	0.8	0.5
10	1	0.7	0.4

Increased conductivity resulted in decreased resistance values. Two salt blocks did not, however, decrease the resulting resistance by two-fold.

Gelatin Studies

Initial gelatin studies were performed in the small laboratory model to see if a definable relationship existed between resistance and the medium through which the current passes. Data is recorded in Appendix 1, pages A1-17 through A1-29.

The three gelatin blocks were evaluated in the small tank were reverse osmosis water gelatin, leachate gelatin and copper leachate gelatin. Each was evaluated at various moisture conditions and two sand compaction conditions. Further the reverse osmosis water gelatin was evaluated at centered and off-centered positions. Summary sheets for these evaluations are found on pages IV-15 and IV-16.

Resistance values for pure gelatin were markedly higher than both the leachate gelatin and copper leachate gelatin at all depths and probe spacings, approximately 45 percent higher than leachate gelatin at 10 percent moisture conditions. This relationship held true for 10 percent and 25 percent moisture conditions and both slight and heavy compaction conditions.

GELATIN STUDIES SUMMARY SHEET SMALL TANK
3" ROD AT VARIOUS MOISTURE AND COMPACTION CONDITIONS

LEACHATE BLOCK DATA

10%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	47.9	27.1
8	42.3	24.4
4	41	20.2

25%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	47.8	28.8
8	41.6	25.8
4	43.4	23.2

25%SAT/HEAVY

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	45.6	25
8	40.3	20.7
4	42.8	19.5

COPPER BLOCK DATA

10%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	40.2	23
8	33	20.2
4	40	20.6

25%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	70.2	41.4
8	59.4	44
4	56.1	32.6

25% SAT/HEAVY

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	52.9	30.3
8	48.2	29.2
4	45.4	24.5

GELATIN STUDIES SUMMARY SHEET SMALL TANK
3" ROD AT VARIOUS MOISTURE AND COMPACTION CONDITIONS

GELATIN BLOCK DATA

10%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	77.6	50.8
8	71.9	40.6
4	68.9	41.9

25%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	89.7	45.7
8	93.3	47.6
4	88.8	43.3

25%SAT/HEAVY

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	85	45.7
8	63.6	37.1
4	55.7	30.4

35%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	92.3	40.8
8	94.4	41.1
4	96.2	40

35%SAT/HEAVY

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 1"	2"
12	85.6	48.5
8	66	33.8
4	56.7	33

Leachate gelatin had higher resistance values than copper leachate gelatin at the 10 percent moisture condition (approximately 5 percent higher). However, the copper leachate had higher resistance values for the 25 percent moisture condition for both slightly and heavily compacted sand, between 16 percent and 30 percent higher, respectively.

The effect of moisture was evident. As the moisture conditions increased, the resulting resistance values increased for all three gelatin blocks studied. The pure gelatin block evaluated at 10 percent and 25 percent moisture conditions showed an increase in resistance as the moisture increased for the 1 inch submerged depth, however, the 2 inch submerged depth showed a less defined increase. The 35 percent moisture evaluation showed higher resistance values for the 1 inch depth, but a decrease in resistance for the 2 inch depth when compared to the 25 percent moisture condition. This suggests that the moisture condition tended to maximize its effect on resistance data at that depth and moisture condition.

Pure gelatin blocks were evaluated centered and off-centered with the 3 inch rod and 6 inch rod. The results are on page IV-18. Again, resistance values increased with increased probe spacing and decreased with increase probe depth. The off-centered gelatin

SUMMARY OF INITIAL GELATIN DATA SMALL TANK
FOR 6" AND 3" ROD

GELATIN STUDIES SMALL TANK 6" ROD

GELATIN CENTERED
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	3	2.6	1
12	2.3	2.1	0.8
8	2.6	2.3	1.1
4	2.9	2.4	1

GELATIN 4"LEFT WALL
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
2	2.4	1.5	0.9
4	2.1	1.5	1
6	2.2	1.5	0.8
8	2.3	1.5	0.9
10	2.6	1.4	1.1

GELATIN STUDIES SMALL TANK 3" ROD

GELATIN CENTERED
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
16	8.1	3.2
12	7.8	2.8
8	7.3	3.1
4	6.6	3.1

GELATIN 4" LEFT WALL
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
2	5.6	2.4
4	5.2	2.5
6	4.7	2.7
8	5.2	2.9
10	4.6	3.1

block data produced a resistance pattern similar to the data from the centered gelatin block. This confirmed the results found earlier in the paraffin block evaluations.

The summary table on page IV-20 lists the mean resistance data for the three gelatin blocks evaluated with the 6 inch rod. The mean resistance values and resistivity data are plotted on pages IV-21 through IV-25. The graphs visually illustrate the resistance relationships of depth and probe spacing. Further, the graphs on pages IV-24 and IV-25 compare resistance data from 10 percent moisture conditions and 35 percent moisture conditions on the pure gelatin block.

GELATIN STUDIES SUMMARY SHEET SMALL TANK

COPPER BLOCK DATA SMALL TANK 6" ROD
10%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 2"	3"	4"
12	29.7	19.5	23.0
8	27.4	16.1	30.1
4	24.8	18.9	11.1

LEACHATE BLOCK DATA SMALL TANK 6" ROD
10%SAT/SLIGHT

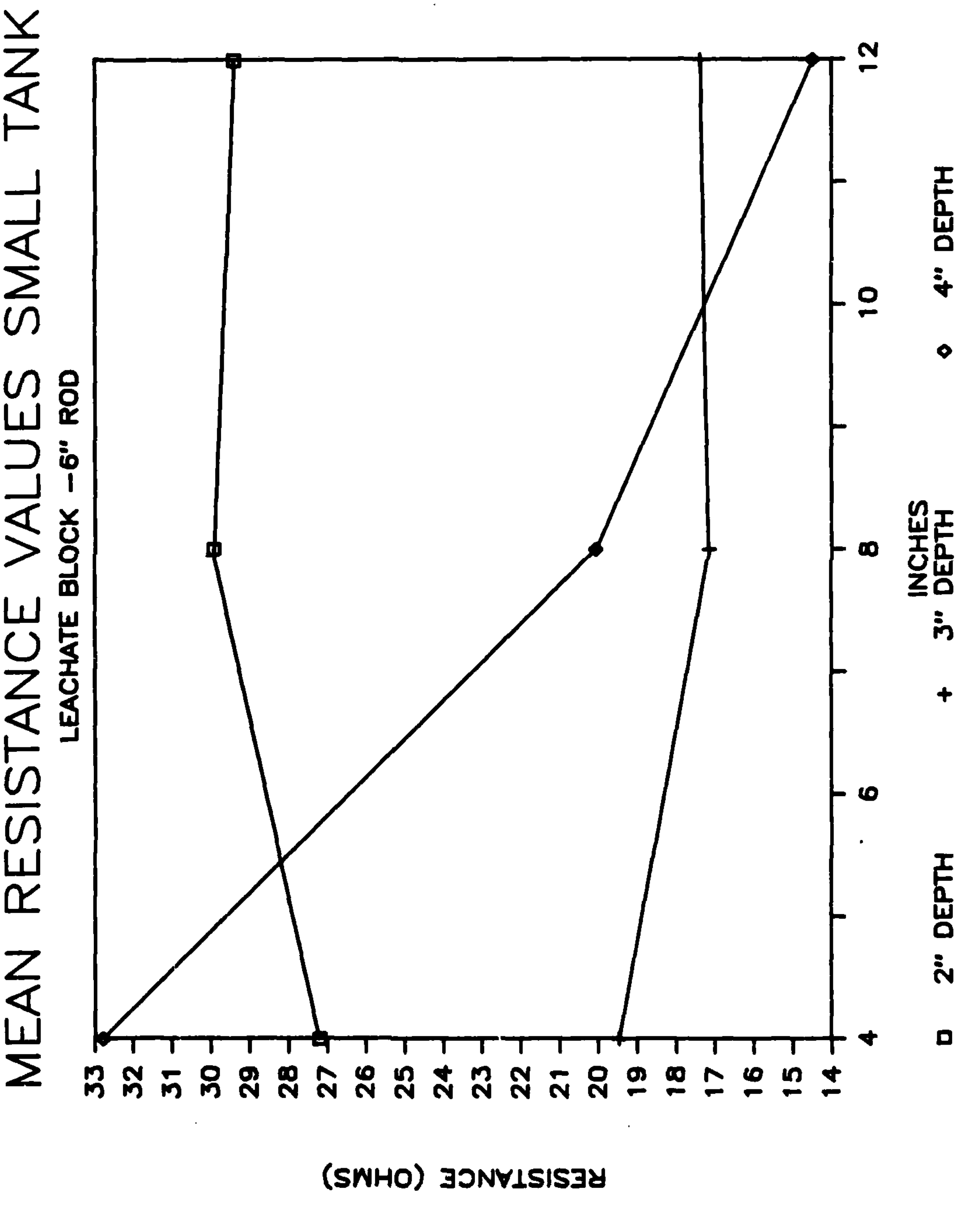
DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 2"	3"	4"
12	29.4	17.4	14.5
8	29.9	17.2	20.1
4	27.2	19.5	32.8

GELATIN BLOCK DATA SMALL TANK 6" ROD
10%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 2"	3"	4"
12	46.4	23.8	12.2
8	45.6	23.3	12.3
4	38.4	20.3	14.2

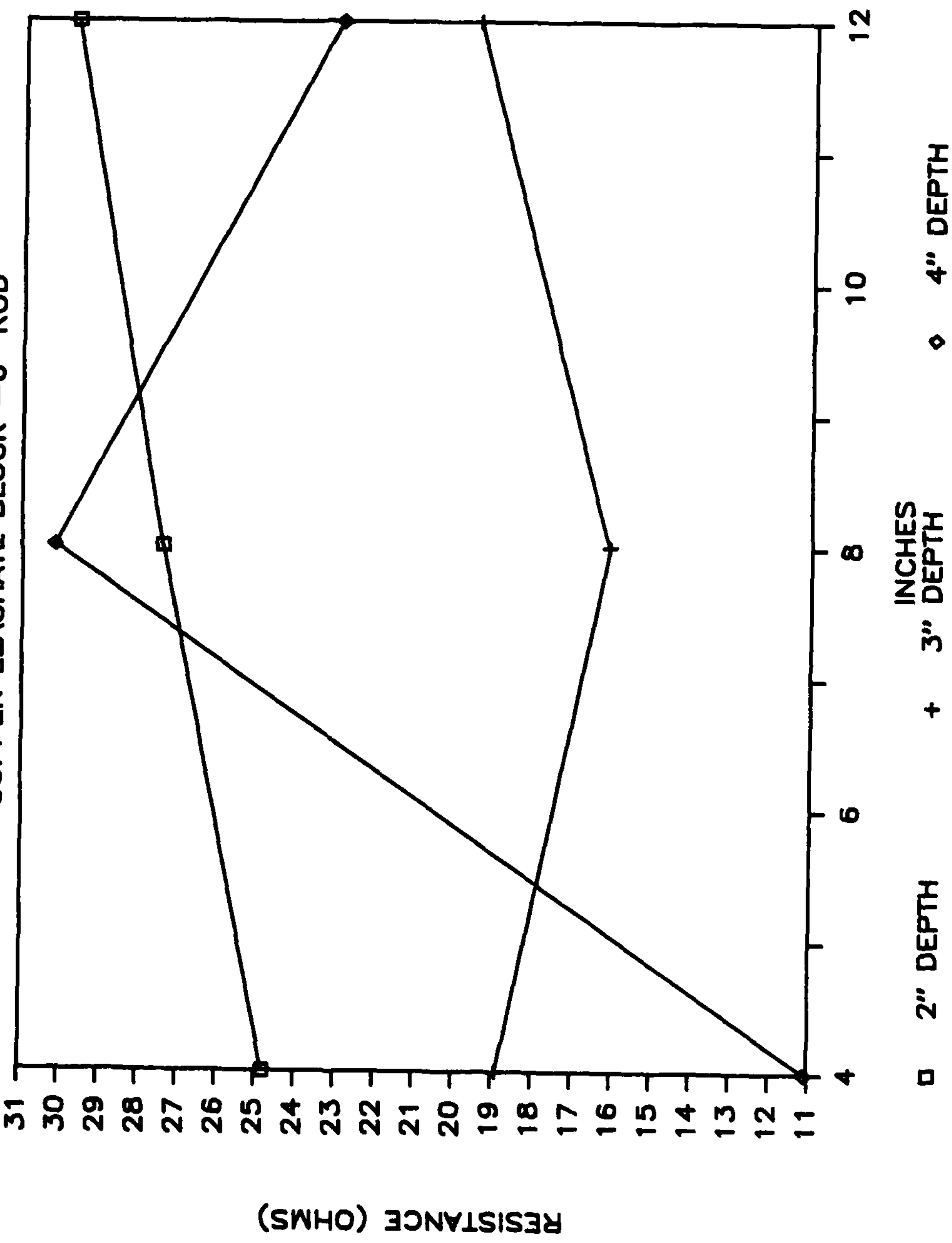
GELATIN BLOCK DATA SMALL TANK 6" ROD
35%SAT/SLIGHT

DISTANCE APART (INCHES)	RESISTANCE (OHMS) DEPTH 2"	3"	4"
12	40.7	19.9	12
8	49.4	19.3	12
4	43.2	23.6	12.9


MEAN RESISTANCE VALUES SMALL TANK
LEACHATE BLOCK -6" ROD
RESISTANCE (OHMS)
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
4
6
8
10
12
INCHES
□ 2" DEPTH
+ 3" DEPTH
◇ 4" DEPTH

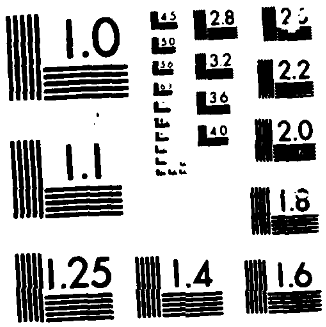
MEAN RESISTANCE VALUES SMALL TANK

COPPER LEACHATE BLOCK –6" ROD

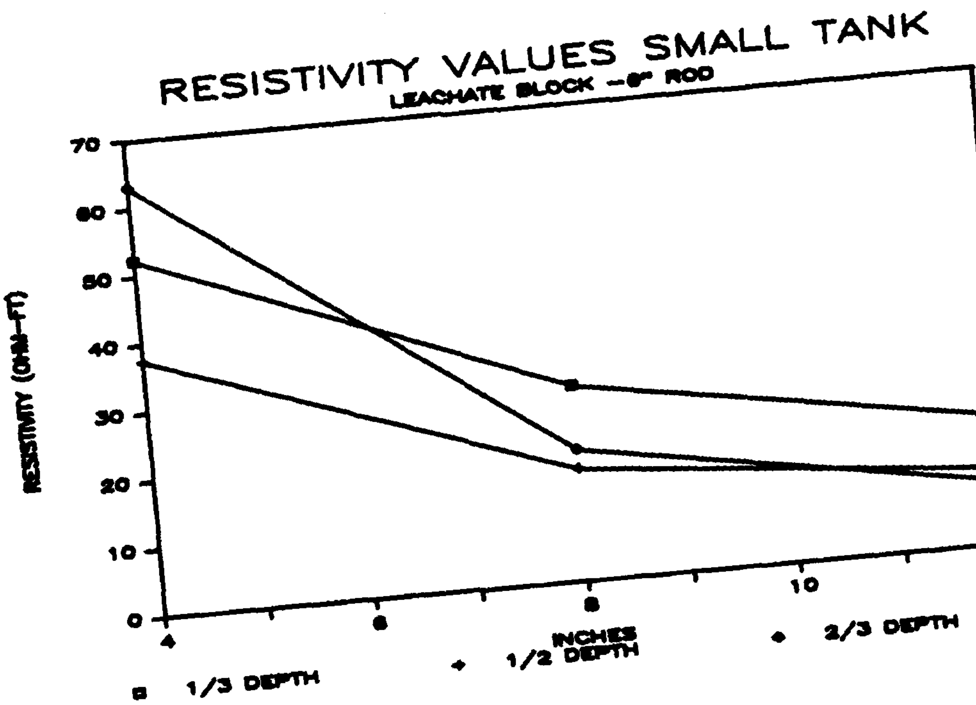


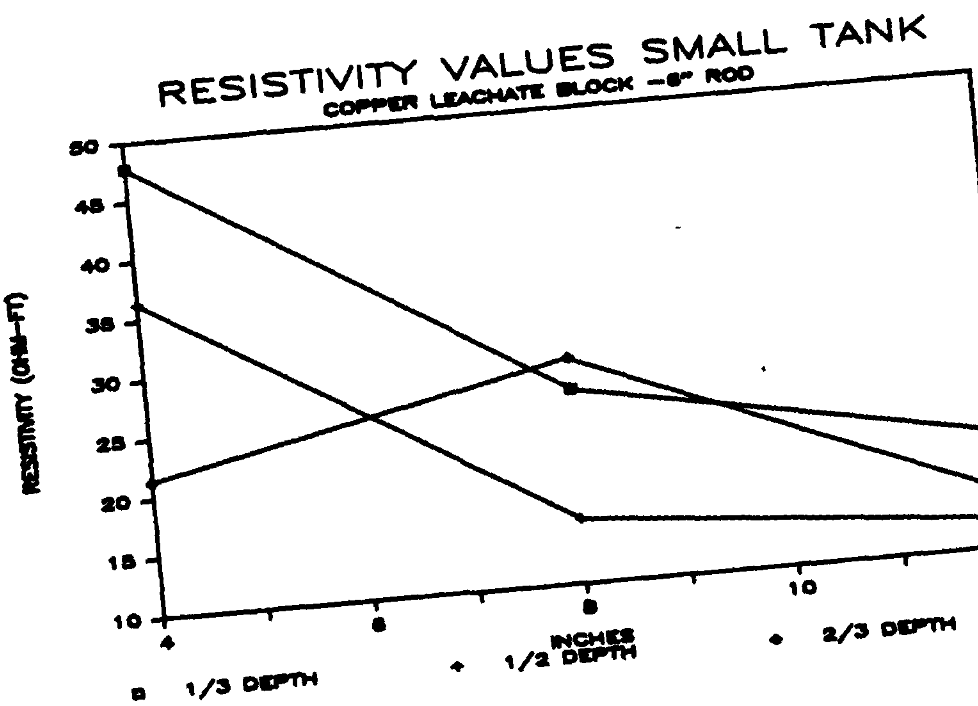
AD-A166 405   STUDY OF ELECTRICAL RESISTIVITY ON THE LOCATION AND   2/3
IDENTIFICATION OF CONTAMINATION(U) AIR FORCE INST OF
TECH WRIGHT-PATTERSON AFB OH B D MCCARTY 1985

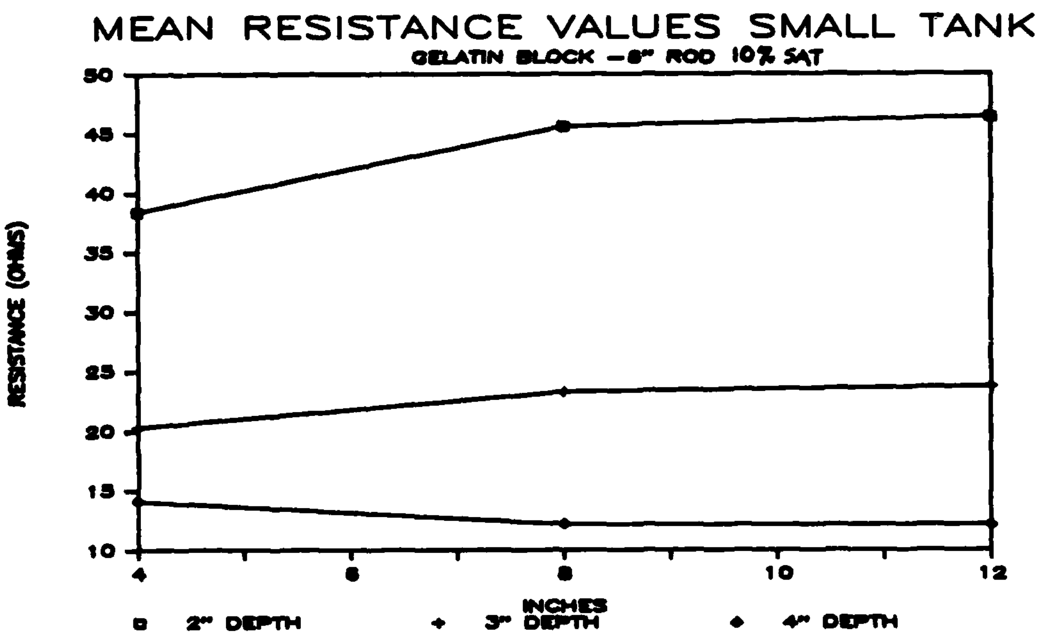
UNCLASSIFIED   AFIT/CI/NR-86-14T   F/G 20/3   NL

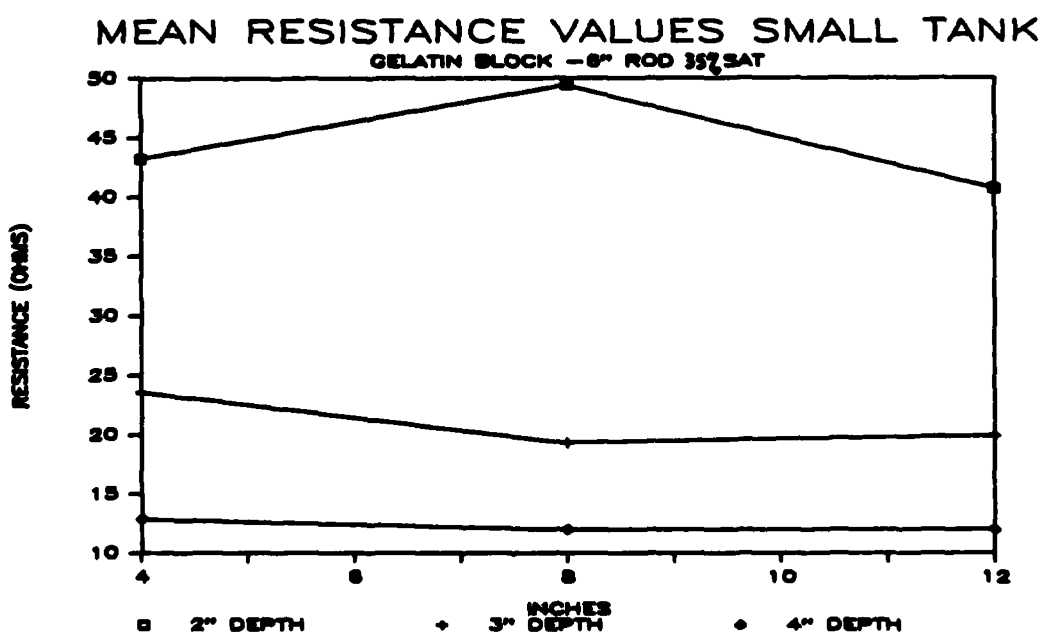


MICROCOPY RESOLUTION TEST CHART


RESISTIVITY VALUES SMALL TANK
LEACHATE BLOCK -6" ROD
RESISTIVITY (OHM-FT)
INCHES
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH

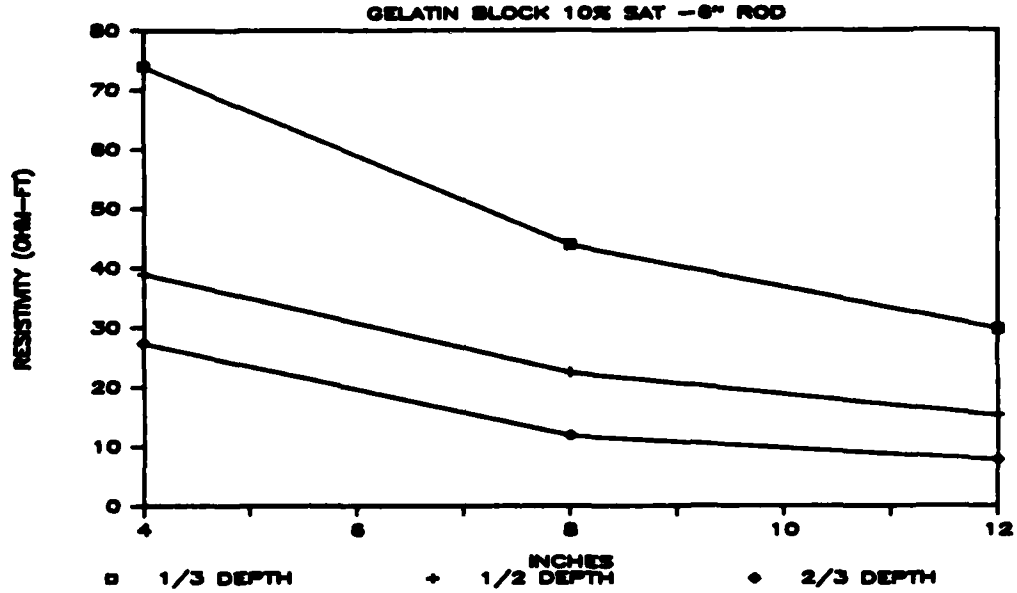

RESISTIVITY VALUES SMALL TANK
COPPER LEACHATE BLOCK -6" ROD
RESISTIVITY (OHM-FT)
INCHES
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH


MEAN RESISTANCE VALUES SMALL TANK
GELATIN BLOCK -8" ROD 10% SAT
RESISTANCE (OHMS)
50
45
40
35
30
25
20
15
10
4
6
8
10
12
INCHES
2" DEPTH
3" DEPTH
4" DEPTH


MEAN RESISTANCE VALUES SMALL TANK
GELATIN BLOCK -8" ROD 35% SAT
RESISTANCE (OHMS)
50
45
40
35
30
25
20
15
10
4
6
8
10
12
INCHES
2" DEPTH
3" DEPTH
4" DEPTH

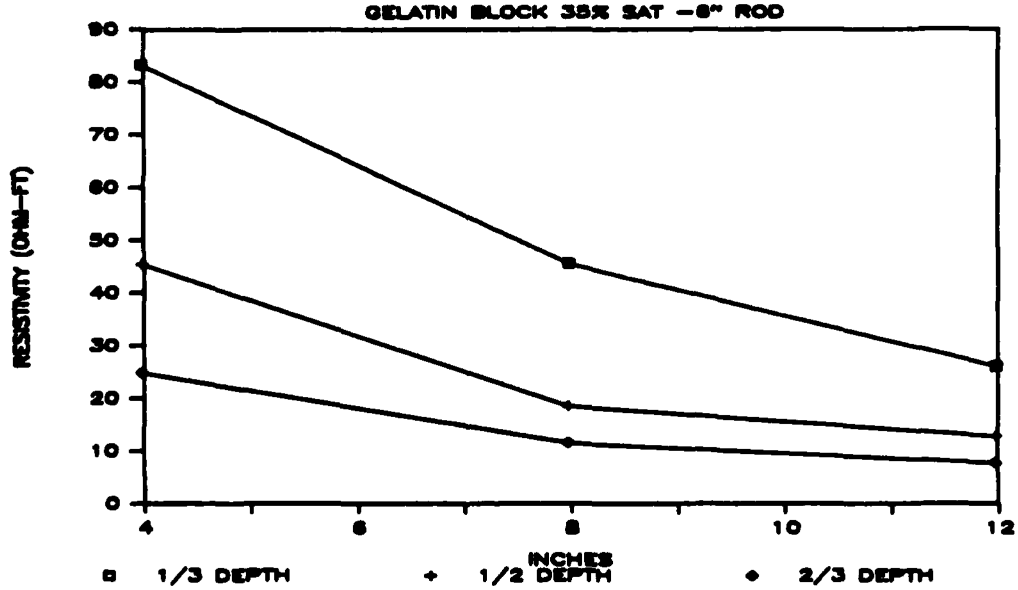
RESISTIVITY VALUES SMALL TANK

GELATIN BLOCK 10% SAT -6" ROD



RESISTIVITY VALUES SMALL TANK

GELATIN BLOCK 35% SAT -6" ROD

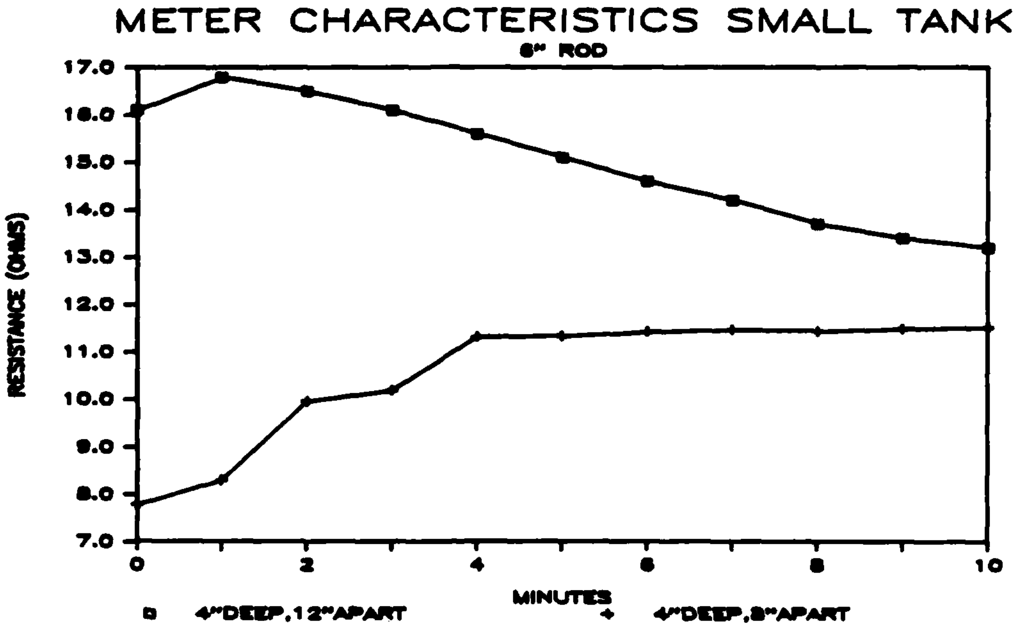


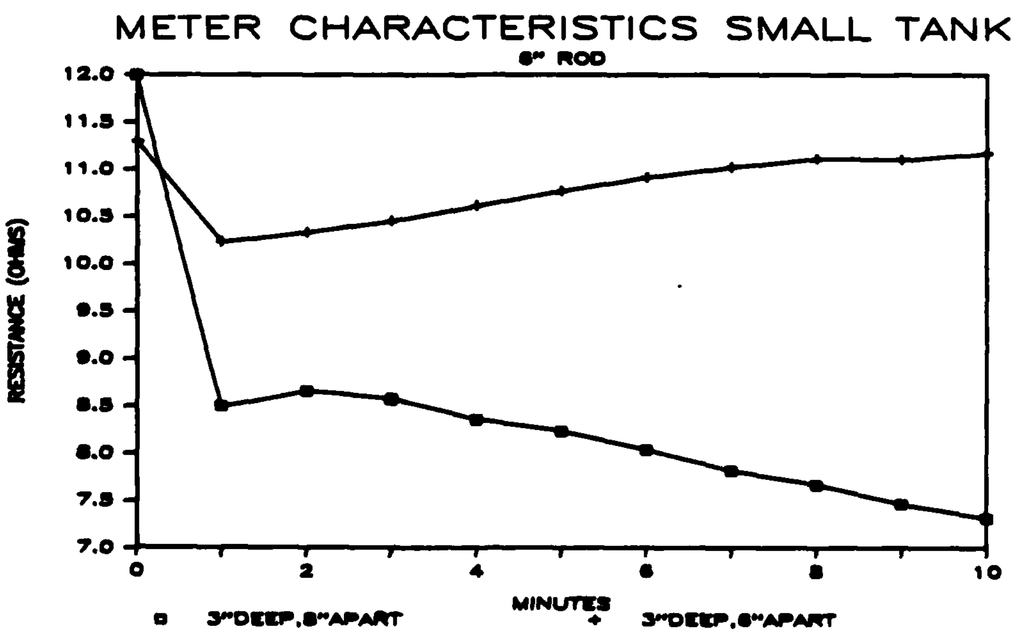
Meter Characteristics

It was noted throughout the evaluations in the small tank that the longer the time between data collection the lower the resistance value. This was probably more due to meter stabilization than any other factor.

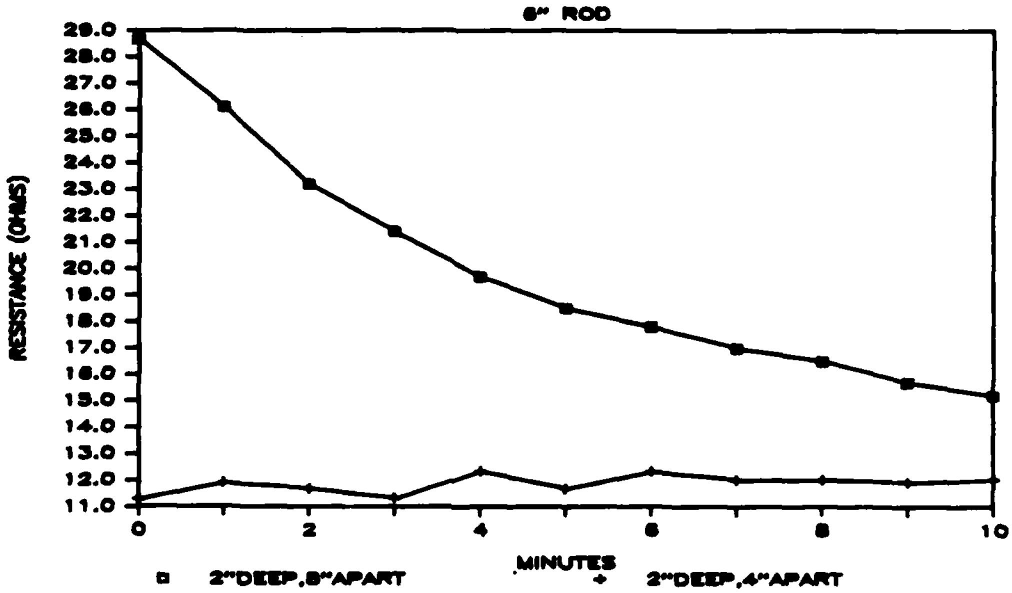
This meter characteristic was evaluated in the small tank by evaluating the resistance change over a ten minute period for various rod depths and spacings on the 6 inch rod. Data values are found in Appendix 1, pages A1-30, A1-31, and A1-32. The results are graphed on pages IV-27 and IV-28.

All the configurations evaluated showed a smooth curve over time and stabilized within the ten minutes of the evaluation. Even though most of the configurations showed a general decreasing trend as time progressed, the evaluation was not carried out extensively enough to prove or disprove this meter characteristic.

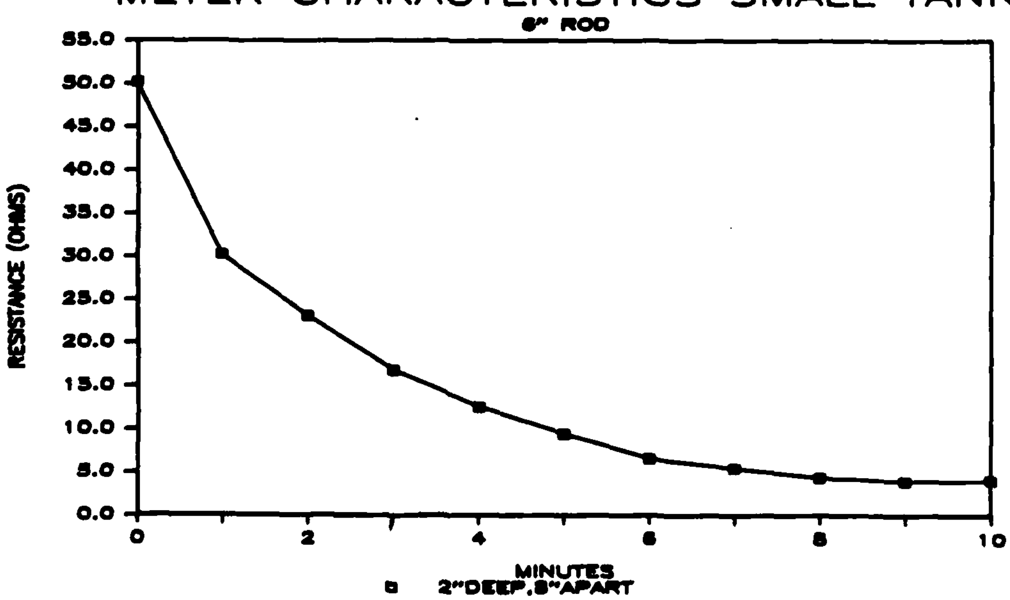

METER CHARACTERISTICS SMALL TANK
6" ROD
RESISTANCE (OHMS)
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
0
2
4
6
8
10
MINUTES
4"DEEP,12"APART
4"DEEP,8"APART


METER CHARACTERISTICS SMALL TANK
6" ROD
RESISTANCE (OHMS)
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
0
2
4
6
8
10
MINUTES
3"DEEP,8"APART
3"DEEP,6"APART

METER CHARACTERISTICS SMALL TANK



METER CHARACTERISTICS SMALL TANK



Large Tank

Initial Resistance Relationships

Seventeen evaluations were performed in the large tank initially on gelatin blocks to see if the relationships found in the small laboratory model could be reproduced in the large laboratory model. Also, the data collection was evaluated using the breadboard circuit assembly.

The comparison of large (19 inch) rod sets to the small (8 inch) rod sets illustrated that the large rods had consistently lower resistance values at almost all depth and rod spacings while passing current through gelatin, and leachate blocks. The same relationship was found in the small tank rod length evaluations. The large rods showed very low resistance readings the further they were submerged because the rods were in contact with the super saturated layer of the large tank. Data evaluation sheets for the large and small rod evaluations are found on pages IV-30 to IV-37. Corresponding data sheets are found in Appendix 2, pages A2-1 through A2-10.

Probe spacing data developed the same relationships in the large model that had been previously defined in the small model. The further the

INITIAL STUDIES LARGE TANK
GELATIN BLOCK
SMALL ROD

1/3 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV	MAX	MIN
16	EAST	890.1	1171.7	3180	80
	CENTER	317.2	216.4	714	91
	WEST	334.1	238.9	779	63.3
12	EAST	313.4	183.5	570	145.8
	CENTER	230.3	214.1	647	33.3
	WEST	348.0	505.2	1355	25.6
8	EAST	264.3	185.3	613	106.7
	CENTER	199.8	200.7	595	45.9
	WEST	84.9	36.4	147.3	40.2
4	EAST	195.0	106.6	386	81.1
	CENTER	155.4	98.7	334	47.2
	WEST	154.8	102.7	317	40.7

1/2 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV	MAX	MIN
16	EAST	351.1	250.5	729	83.6
	CENTER	262.8	146.6	532	127.5
	WEST	232.2	264.0	753	35.6
12	EAST	197.2	139.5	474	104.2
	CENTER	165.9	171.3	504	29.7
	WEST	87.5	52.5	178.7	15.8
8	EAST	124.3	98.3	317	42.6
	CENTER	86.4	48.3	174.6	27.1
	WEST	80.1	48.1	168.9	23.4
4	EAST	72.0	21.4	101.3	38.5
	CENTER	65.9	27.4	106	22.1
	WEST	66.4	28.0	106.9	18.9

INITIAL STUDIES LARGE TANK
GELATIN BLOCK
SMALL ROD

2/3 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV	MAX	MIN
16	EAST	280.2	106.6	472	181
	CENTER	268.1	169.0	577	125.2
	WEST	160.9	158.5	471	28.7
12	EAST	233.3	226.8	683	95.3
	CENTER	127.4	122.9	370	30
	WEST	70.5	41.0	143.4	16.1
8	EAST	107.9	99.8	305	31.9
	CENTER	67.7	37.3	134.8	20
	WEST	59.1	33.8	120	15.7
4	EAST	52.7	22.0	85.8	13.1
	CENTER	51.7	19.4	73.9	15.9
	WEST	50.4	26.7	90.3	7.5

INITIAL STUDIES LARGE TANK
GELATIN BLOCK
LARGE ROD

1/3 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV.	MAX	MIN
16	EAST	244.5	122.1	472	129
	CENTER	129.6	68.0	218	22
	WEST	93.3	39.9	160.7	36
12	EAST	107.5	39.2	148	45.1
	CENTER	385.6	558.6	1502	74.1
	WEST	79.7	43.4	154.9	21.9
8	EAST	147.7	79.8	296	78.5
	CENTER	84.3	37.3	138.6	32.9
	WEST	71.1	32.7	107.4	21.6
4	EAST	128.1	31.9	186.5	99.5
	CENTER	70.2	26.7	109	27.9
	WEST	61.2	27.3	107.8	23.9

1/2 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV.	MAX	MIN
16	EAST	380.2	291.3	742	83
	CENTER	412.0	409.1	1204	106.3
	WEST	94.4	36.9	161.2	63.2
12	EAST	425.7	682.2	1790	66.8
	CENTER	316.9	504.6	1326	57
	WEST	51.0	14.5	72.8	28
8	EAST	60.7	28.2	104	19.4
	CENTER	61.1	6.8	68	48.2
	WEST	50.5	6.5	61.5	41.8
4	EAST	39.9	15.1	54.6	12.8
	CENTER	35.3	12.7	52.2	13.4
	WEST	34.1	14.5	48.1	7

INITIAL STUDIES LARGE TANK
GELATIN BLOCK
LARGE ROD

2/3 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV.	MAX	MIN
16	EAST	846.4	603.7	2010	288
	CENTER	442.5	347.5	1100	105.6
	WEST	95.1	20.6	132	70
12	EAST	387.7	623.0	1633	49.9
	CENTER	62.8	9.1	77.6	52.1
	WEST	62.6	18.6	94.9	46.6
8	EAST	53.0	26.0	100.1	20.2
	CENTER	61.2	11.5	77.5	46.8
	WEST	59.6	12.7	79.7	42.6
4	EAST	37.8	12.4	49.4	14
	CENTER	29.8	6.6	38.1	17.91
	WEST	36.4	9.7	47.3	19.42

INITIAL STUDIES LARGE TANK
LEACHATE BLOCK
SMALL ROD

1/3 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV	MAX	MIN
16	EAST	355.3	343.5	928	78
	CENTER	366.9	294.6	703	51.9
	WEST	242.4	179.6	474	43.9
12	EAST	287.6	168.5	485	51.5
	CENTER	210.4	141.3	359	45.7
	WEST	240.8	183.3	456	39.4
8	EAST	195.1	122.2	330	53.6
	CENTER	216.0	158.2	404	41
	WEST	207.3	150.8	388	43.5
4	EAST	236.5	169.8	427	49.1
	CENTER	196.3	144.1	392	43.2
	WEST	206.6	156.3	413	39.8

1/2 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV	MAX	MIN
16	EAST	225.3	244.3	643	47.5
	CENTER	183.3	172.4	470	38.2
	WEST	138.6	114.5	327	36.7
12	EAST	107.0	53.6	186.9	38.8
	CENTER	97.6	47.7	153.9	37.9
	WEST	94.7	49.2	152.8	33.6
8	EAST	88.5	36.3	133.5	40.4
	CENTER	100.1	53.4	164.2	34.2
	WEST	87.8	40.2	130.7	35.3
4	EAST	96.2	45.7	143.4	38.9
	CENTER	92.5	46.6	150.1	35.5
	WEST	81.9	41.7	133.9	30.9

INITIAL STUDIES LARGE TANK
LEACHATE BLOCK
SMALL ROD

DIST APART (FEET)		2/3 DEPTH RESISTANCE (OHMS)			
		MEAN	STD.DEV	MAX	MIN
16	EAST	222.7	262.7	675	42.1
	CENTER	165.4	165.4	447	39.5
	WEST	98.2	63.3	196	34
12	EAST	92.2	49.1	168.3	36.5
	CENTER	87.3	44.6	148.1	33.4
	WEST	84.7	42.4	137.2	31.7
8	EAST	84.1	38.4	137.5	35.8
	CENTER	85.6	42.7	135.3	32.5
	WEST	81.4	38.1	129.8	33.8
4	EAST	76.0	32.7	113.8	34.4
	CENTER	75.6	33.9	116	31.6
	WEST	72.4	33.6	112.4	30.6

INITIAL STUDIES LARGE TANK
LEACHATE BLOCK
LARGE ROD

1/3 DEPTH
RESISTANCE (OHMS)

	DIST APART (FEET)	MEAN	STD.DEV	MAX	MIN
16	EAST	507.5	126.5	634	381
	CENTER	484	28	512	456
	WEST	245.3	83.7	329	161.6
12	EAST	196.25	48.75	245	147.5
	CENTER	185.05	13.25	198.3	171.8
	WEST	233.95	83.05	317	150.9
8	EAST	214.8	73.2	288	141.6
	CENTER	317.2	126.8	444	190.4
	WEST	243.35	108.65	352	134.7
4	EAST	179.3	5.1	184.4	174.2
	CENTER	140.2	23.5	163.7	116.7
	WEST	110.1	38.7	148.8	71.4

1/2 DEPTH
RESISTANCE (OHMS)

	DIST APART (FEET)	MEAN	STD.DEV	MAX	MIN
16	EAST	273.7	125.3	399	148.4
	CENTER	209.65	116.35	326	93.3
	WEST	134.85	51.55	186.4	83.3
12	EAST	86.55	17.45	104	69.1
	CENTER	87.7	9.4	97.1	78.3
	WEST	81.75	9.95	91.7	71.8
8	EAST	85.4	10.3	95.7	75.1
	CENTER	92.05	10.35	102.4	81.7
	WEST	81.05	9.25	90.3	71.8
4	EAST	79.45	2.35	81.8	77.1
	CENTER	75.9	6.6	82.5	69.3
	WEST	57.25	9.85	67.1	47.4

INITIAL STUDIES LARGE TANK
LEACHATE BLOCK
LARGE ROD 2/3 DEPTH
RESISTANCE (OHMS)

DIST APART (FEET)		MEAN	STD.DEV	MAX	MIN
16	EAST	563.3	420.7	984	142.6
	CENTER	312.05	197.95	510	114.1
	WEST	104.3	22.6	126.9	81.7
12	EAST	74.7	18.8	93.5	55.9
	CENTER	73.9	13	86.9	60.9
	WEST	69.75	10.65	80.4	59.1
8	EAST	73.6	7.8	81.4	65.8
	CENTER	94.3	8	102.3	86.3
	WEST	81.35	14.75	96.1	66.6
4	EAST	56.65	4.65	61.3	52
	CENTER	67.3	6.7	74	60.6
	WEST	60.9	11.1	72	49.8

distance between the rods, the higher the resistance value based on more volume of sand to pass the current through.

It was also noted that the comparison of compaction methods showed no definable pattern of resistance data that could be separated from the high standard deviation of the data. Also, the order of data collection did not show a definable influence on the data results.

Generally, the standard deviation of the data collected was higher at the 16 foot spacing than the 4 foot spacing for all three rod depth evaluations. Neither the large rod nor the small rod showed a better overall precision for data collection.

The breadboard circuit was evaluated in conjunction with the LCD Meter. Overall, the meter was shown to read the smaller of the two resistors in the circuit. This would mean that the meter would record the smaller resistance value between the sand resistance in the large tank and the resistor in the breadboards circuit. If the breadboard circuit were kept high (10M Ω), then the meter would read the resistance of the sand.

The major problem in using the breadboard would be converting the resulting resistance into meaningful data. The breadboard was not required when it was

discovered that the 10 percent moisture content increased sand conduction enough to lower resistance values to a reading that could be recorded on the LCD meter.

Gelatin Studies

Having confirmed the relationships of probe depth and spacing, the small set of rods were chosen to run all gelatin studies for two reasons. First, the resistance values were found to be in the middle ranges of the meter, and therefore, felt to be more accurate. Second, it was felt that the large rods would come in contact with the super saturated layer of sand in the tank, and therefore, give erroneous readings at the 2/3 submerged depth.

The same three gelatin recipes were used in the large laboratory evaluation as in the small laboratory evaluation. The results are summarized on pages IV-40 and IV-41.

Thirty data runs of thirty-six points each were performed on gelatin, leachate gelatin and copper leachate gelatin blocks.

The data for the leachate block is found in Appendix 2, pages A2-11 to A2-25. The gelatin block data is found on pages A2-26 to A2-40 and the copper leachate block data is found on pages A2-41 to A2-55.

DATA SUMMARY SHEETS LARGE TANK

LEACHATE DATA SUMMARY RESISTANCE (OHMS)

DIST. APART (FT)		1/3 MEAN	1/3 STD.DEV	1/2 MEAN	1/2 STD.DEV.	2/3 MEAN	2/3 STD.DEV.
16	EAST	1063.8	1911.3	560.1	156.8	783.9	1837.8
	CENTER	421.1	257.7	297.5	236.5	225.4	199
	WEST	358.1	212.9	223.1	139.4	242	207.6
12	EAST	437.3	421.4	288.6	509.7	208	187.6
	CENTER	267.8	191.7	192.7	177.4	161.2	155.4
	WEST	194.2	108.3	130.9	99.4	124.7	111.6
8	EAST	316.8	250.6	153.8	120.1	152.8	177.3
	CENTER	216.5	301	118.7	87.9	111.4	104.8
	WEST	136.3	86.5	100.6	63.8	95.3	73.6
4	EAST	236.1	168.7	108.8	68	87.8	69.1
	CENTER	119.3	60.1	79.3	34.1	70.1	31.9
	WEST	102	38.8	71.7	26.2	62.7	23.1

GELATIN DATA SUMMARY RESISTANCE (OHMS)

DIST. APART (FT)		1/3 MEAN	1/3 STD.DEV.	1/2 MEAN	1/2 STD.DEV.	2/3 MEAN	2/3 STD.DEV.
16	EAST	1330.3	1047.3	603.4	299	886.2	1827.5
	CENTER	791.9	259.8	535.8	199.9	406.8	160.2
	WEST	683.6	241.5	533.5	228.8	406.9	176.2
12	EAST	774.3	496.3	367.4	118.2	431.3	267.9
	CENTER	637.6	362.4	407.2	335.5	278.3	134.1
	WEST	444.4	190	321.4	159.7	264.3	123.8
8	EAST	556.5	188.3	301.7	106.2	249.3	112.5
	CENTER	368.1	143.2	253	132	193.2	102
	WEST	294.2	113.7	206.3	94	177	93.7
4	EAST	481.3	237.7	242.1	113.1	204.8	132
	CENTER	309.9	135.7	192.1	111	139.9	61.4
	WEST	248	107.8	172.2	87	137.6	75.1

DATA SUMMARY SHEETS LARGE TANK

COPPER LEACHATE DATA SUMMARY

		RESISTANCE (OHMS) DEPTH					
DIST.		1/3		1/2		2/3	
APART (FT)		MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
16	EAST	3456.9	2663.5	2689.4	2520.4	1690.5	1555.3
	CENTER	4074.7	2390.9	2428.1	1964.5	1055.9	680.2
	WEST	4867.8	2957.8	3650.2	2564.7	2290.9	1966.3
12	EAST	2444.2	1298.3	945.6	267.2	742.2	264.2
	CENTER	2909.2	2082.2	1027.1	380.6	678.3	239
	WEST	2589.4	1482.3	1014.6	356.9	653	230.2
8	EAST	2344.1	1669.8	703.5	300.2	501.9	227.8
	CENTER	1835.4	1406.4	634.1	207.9	442.7	149.1
	WEST	1139	638.7	635.8	216.5	459	166.4
4	EAST	1570.3	779.6	648.2	276.8	395.8	174.2
	CENTER	1216.6	636.9	557.9	157.1	371.7	104.6
	WEST	1043.4	385.5	573	197.1	389	108.5

All data evaluations, summary tables and graphs come from these appendix sheets.

The LCD Meter used for data collection has a stated accuracy of 2 percent for the 200 Ohm and 2000 Ohm scales and a 4 percent accuracy for the 20 M (20,000) Ohm scale.

Several definable relationships were found. First, the resistance values for the leachate gelatin were always lower (from 10% to 22% lower) than the gelatin block at each probe depth and spacing. The lowered resistance value can be explained by the total dissolved solids content of the leachate used to make the leachate gelatin block. The high TDS content (10,400 mg/l) would mean a higher number of conductive ions present and would result in a lower resistance value.

The standard deviation for the data points for all gelatin blocks ranged from over 100 percent at the 16 foot spacing to 30 percent at the 4 foot spacing. Although this high standard deviation would present some overlap between the gelatin block and leachate block data, it was shown that the leachate block values were consistently lower at all thirty-six of the data collection stations.

Second, the copper sulfate leachate gelatin block showed extremely high resistance values when compared

to the leachate gelatin block. The resistance values for the copper block ranged from four to six times higher than the leachate gelatin block without the 50 ppm copper spike. This high resistance value was related to the nature of the copper sulfate ions in solution, and therefore, did not decrease resistance values as metallic copper would.

The copper leachate resistance values were so much higher than the other gelatin blocks studied that no data overlap could exist between data standard deviations. In short, a definable relationship exists that the resistance values increase tremendously when sulfate metal ions are introduced into the gelatin blocks. This relationship would prove useful when dealing with metal ions in solution as groundwater contamination.

A comparison of the mean resistance values for all three gelatin blocks are found on page IV-44. The mean resistance data is graphed on pages IV-45 and IV-46. Resistivity data comparing each gelatin block at each depth is found on pages IV-47 and IV-48.

MEAN RESISTANCE VALUE SUMMARY SHEET

GELATIN STUDIES

DISTANCE APART (FEET)	RESISTANCE (OHMS) DEPTH 1/3	1/2	2/3
16	935.3	557.6	566.6
12	618.8	365.3	324.6
8	406.3	253.7	206.5
4	346.4	202.1	160.8

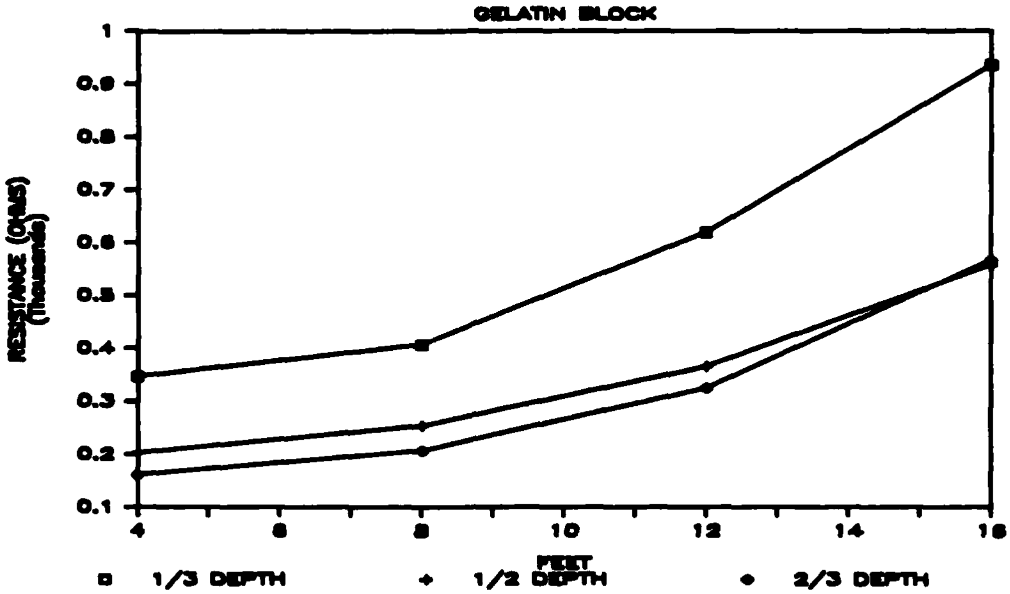
LEACHATE STUDIES

DISTANCE APART (FEET)	RESISTANCE (OHMS) DEPTH 1/3	1/2	2/3
16	614.3	360.2	417.1
12	299.8	204.1	164.6
8	223.2	124.4	119.8
4	152.5	86.6	73.5

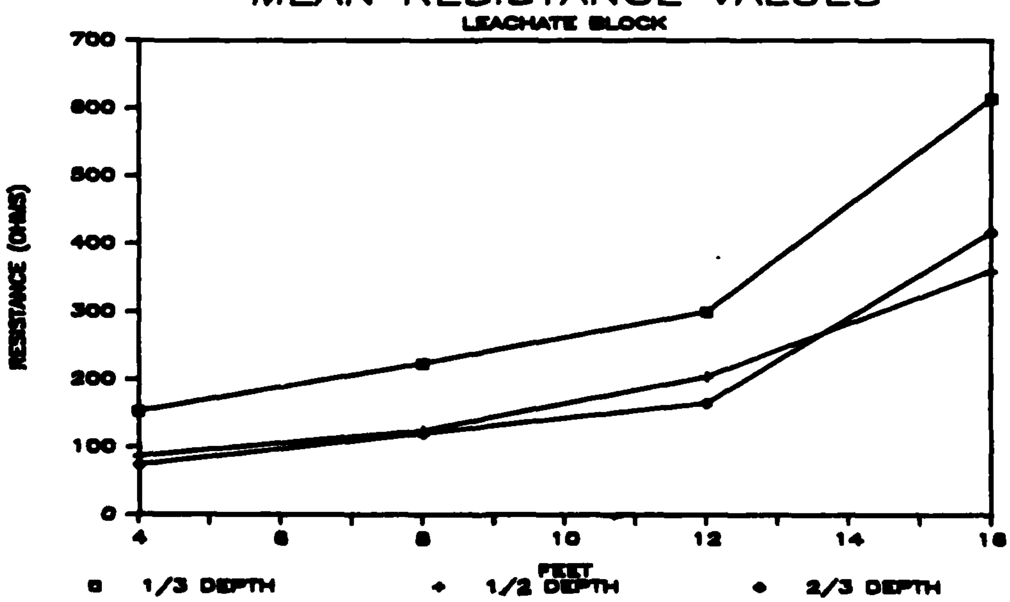
COPPER LEACHATE STUDIES

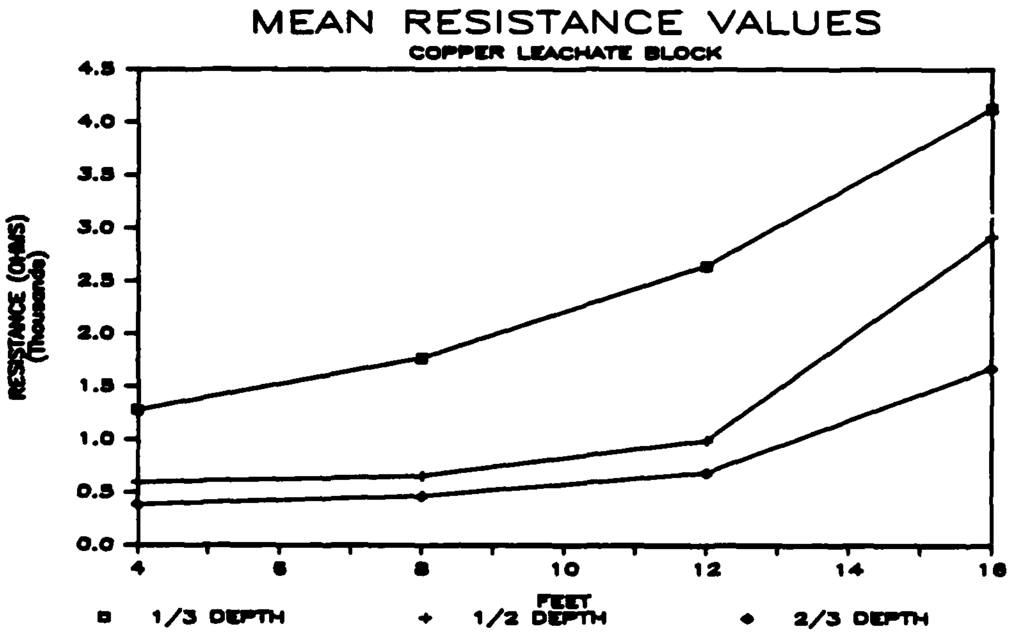
DISTANCE APART (FEET)	RESISTANCE (OHMS) DEPTH 1/3	1/2	2/3
16	4133.1	2922.6	1679.1
12	2647.6	995.8	691.2
8	1772.8	657.8	467.9
4	1276.8	593	385.5

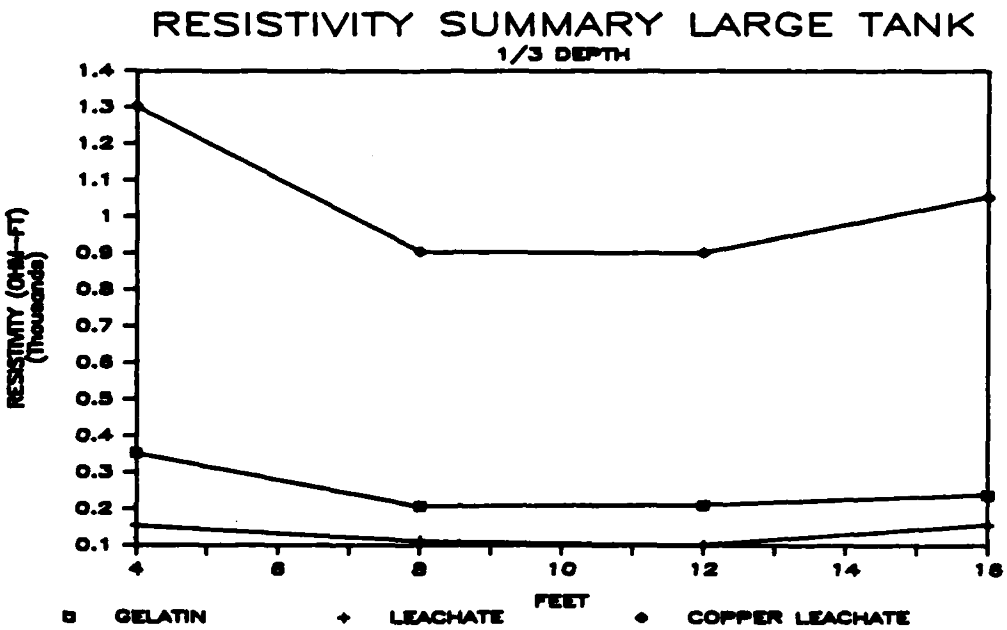
MEAN RESISTANCE VALUES

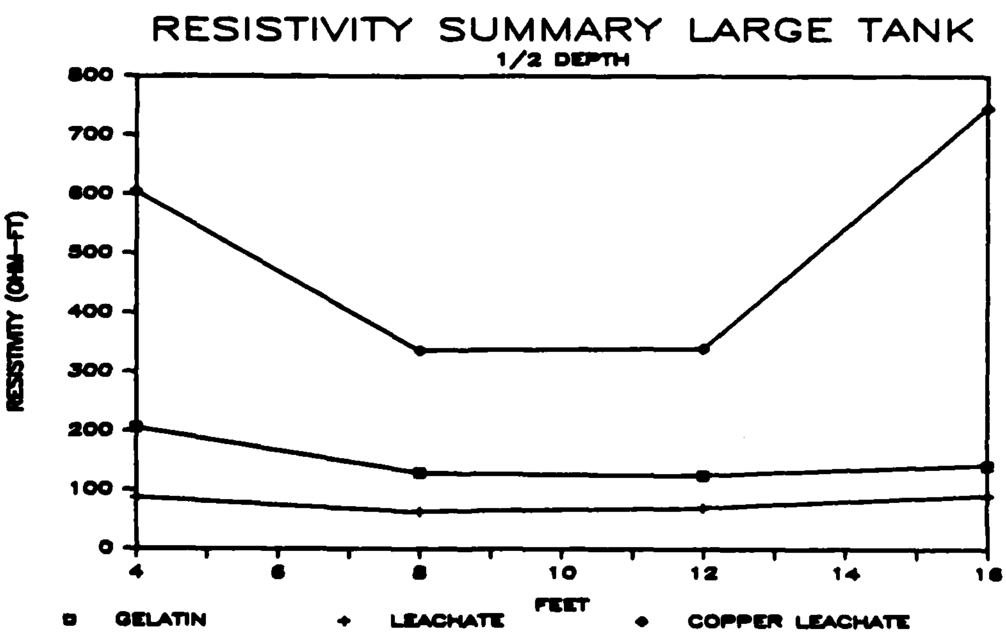


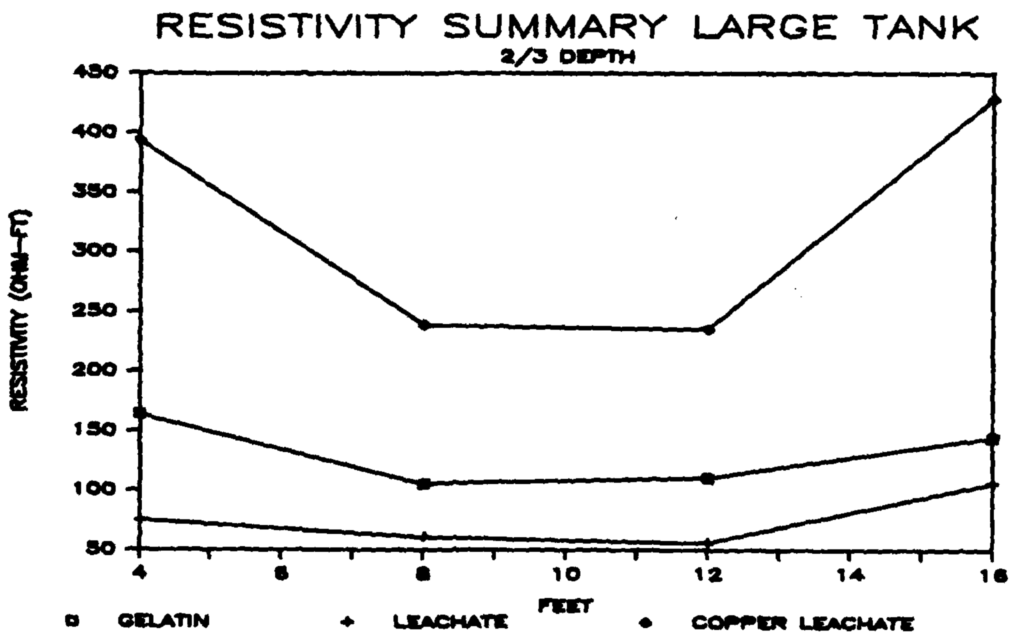
MEAN RESISTANCE VALUES




MEAN RESISTANCE VALUES
COPPER LEACHATE BLOCK
RESISTANCE (OHMS) (Thousands)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4
6
8
10
12
14
16
FEET
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH


RESISTIVITY SUMMARY LARGE TANK
1/3 DEPTH
RESISTIVITY (OHM-FT)
(Thousands)
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
4
6
8
10
12
14
16
FEET
GELATIN
LEACHATE
COPPER LEACHATE


RESISTIVITY SUMMARY LARGE TANK
1/2 DEPTH
RESISTIVITY (OHM-FT)
800
700
600
500
400
300
200
100
0
4
6
8
10
12
14
16
FEET
GELATIN
LEACHATE
COPPER LEACHATE


RESISTIVITY SUMMARY LARGE TANK
2/3 DEPTH
RESISTIVITY (OHM-FT)
450
400
350
300
250
200
150
100
50
4
6
8
10
12
14
16
FEET
GELATIN
LEACHATE
COPPER LEACHATE

Effect of Moisture on Data

Moisture variation is known to have a great effect on resistivity data collection. However, the effect of gravitational pull on the water in the tank was not seen in the data collection throughout the day as originally expected. A comparison of the first and last run of each data collection day showed much higher resistance values for data collected at the beginning of the day. This was not expected. It was assumed that gravity pulling the water to the bottom of the tank would leave the top layers of sand drier. The top layers would then have increased resistance due to limited water content available for electrical conduction as the day progressed. Comparisons of the first and last data runs for each day are found on pages IV-50 to IV-58.

The comparisons of the first and last data runs of each data collection day did not reveal any definable relationship for data collected, but the comparison sheets do show the extreme variability in the data collected.

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE LEACHATE BLOCKS

5 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	LAST	1/2 DEPTH FIRST	LAST	2/3 DEPTH FIRST	LAST
16	EAST	792	166.5	346	101.4	322	87.5
	CENTER	373	129	275	82.3	176.3	75.2
	WEST	344	138.2	153.8	93.8	141.3	77.2
12	EAST	251	133.1	130.4	78.2	102.9	65.7
	CENTER	149.4	93.4	104.4	71.1	95.3	61.8
	WEST	151.5	99.6	105.8	71.6	91.3	61.6
8	EAST	164.6	100.9	110.8	64.3	92.9	57
	CENTER	130.1	90.6	92.3	70.5	79.8	59.1
	WEST	101.6	100.4	83.1	71.3	75.6	60.6
4	EAST	134.2	101.9	98.1	66	84.7	59.8
	CENTER	102.9	83.2	77.7	65.3	75.2	57.1
	WEST	108.7	95.8	81.5	68.9	76.4	60.3

6 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	LAST	1/2 DEPTH FIRST	LAST	2/3 DEPTH FIRST	LAST
16	EAST	1868	196.3	442	75.3	324	64.7
	CENTER	613	116.4	561	74.8	459	62.4
	WEST	597	91.5	388	71.6	316	65.2
12	EAST	290	123.9	186.7	51.4	139.4	50
	CENTER	342	65.8	130.6	51.5	110	49.7
	WEST	137.4	80.7	110.2	54.8	90	49.4
8	EAST	369	71.3	115.9	54.3	93.3	47
	CENTER	118.7	58.5	103.3	53.7	82.7	49.2
	WEST	121.7	66.9	83.7	52.5	70.1	47.5
4	EAST	113.5	81.4	82.5	57.3	73.9	48.4
	CENTER	111.1	61.2	79.3	51.1	65.8	46.1
	WEST	88.5	59.1	69.8	48.8	60.5	41

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE LEACHATE BLOCK

7 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	720	667	417	152	446	131
	CENTER	598	255	367	177	333	130.5
	WEST	578	279	292	173.1	158.3	121.2
12	EAST	408	271	164.7	157.4	128.9	162.5
	CENTER	189	151	127	96	116.2	110.5
	WEST	145.9	157.8	104.8	97.2	92.5	74.3
8	EAST	190.5	242	112.5	95.4	93.2	80.4
	CENTER	115.5	109.7	91.4	75.7	81.1	66.5
	WEST	110.6	89.1	87	63.9	78.9	59.2
4	EAST	398	152.4	101.3	68.2	86.2	60.9
	CENTER	97.8	101.1	78.7	58.5	71.7	50.7
	WEST	93.7	74.1	70.2	59.9	63.5	47.1

8 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	345	1429	288	401	5820	142
	CENTER	385	799	310	158.9	255	139.7
	WEST	628	622	362	153.8	284	145
12	EAST	406	2440	292	2940	256	450
	CENTER	363	391	174.7	105.8	132.9	141.6
	WEST	169.9	199.3	139.9	115.7	122.1	59.7
8	EAST	159.1	349	102	137.9	92.3	76.4
	CENTER	118.5	149.5	103.6	69.7	93.4	61.3
	WEST	106.9	109.9	100.1	61.5	85.3	56.9
4	EAST	162.8	223	99.2	74.1	77	40.8
	CENTER	126.7	74	81	35.6	67.8	41.8
	WEST	90.7	68.5	65.5	29.4	57.2	21.7

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE LEACHATE BLOCK

9 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	1130	535	639	312	552	530
	CENTER	946	653	533	381	1053	300
	WEST	769	475	535	354	458	275
12	EAST	567	656	359	421	358	474
	CENTER	406	403	331	409	301	275
	WEST	307	329	169	226	172.9	224
8	EAST	411	666	191.9	312	166.1	445
	CENTER	197.7	320	152.7	223	120.3	186.8
	WEST	168.9	327	124.9	247	107.9	350
4	EAST	277	319	129	203	NO PT.	192.9
	CENTER	172.9	261	110	158.8	97.2	160.5
	WEST	135.9	190.1	85.9	140.8	76.7	131.8

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE GELATIN BLOCKS

12 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	550	1565	611	419	804	335
	CENTER	511	523	420	455	420	281
	WEST	714	483	431	358	618	357
12	EAST	529	540	336	280	411	389
	CENTER	365	302	276	231	240	181.8
	WEST	309	240	276	150.6	242	157
8	EAST	435	579	273	278	198	174.9
	CENTER	330	335	269	155.3	187.3	129.1
	WEST	277	179.4	183.4	112.6	170.7	114.8
4	EAST	261	310	180	167.5	167.5	135.8
	CENTER	278	151	162.3	97.7	161.7	91
	WEST	193	124.6	144.9	79.7	145	77.6

13 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	4080	1650	1021	684	735	911
	CENTER	822	660	599	501	579	417
	WEST	583	676	637	531	541	524
12	EAST	675	781	434	366	410	507
	CENTER	433	744	524	358	590	326
	WEST	398	438	442	304	432	334
8	EAST	433	723	400	386	409	385
	CENTER	265	656	402	436	194.4	176.5
	WEST	252	376	373	164.7	167.5	165.7
4	EAST	340	326	281	189.6	179.6	167
	CENTER	274	336	162.8	136.4	145.3	119.5
	WEST	265	164.8	160.6	124	156	110.7

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE GELATIN BLOCKS

14 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	1117	1054	577	542	10600	452
	CENTER	1025	1087	788	1007	571	507
	WEST	674	920	719	649	478	527
12	EAST	576	3140	373	496	570	470
	CENTER	552	689	387	1994	301	436
	WEST	426	566	321	549	280	368
8	EAST	385	900	278	439	196.1	381
	CENTER	515	627	266	636	295	344
	WEST	273	319	181.8	300	159.9	316
4	EAST	359	959	194.4	367	160.8	313
	CENTER	261	321	177.9	285	174.8	262
	WEST	188.2	236	132	211	114.7	190.5

15 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	598	3070	433	946	391	671
	CENTER	504	1101	459	626	419	784
	WEST	443	1216	389	558	382	410
12	EAST	442	1096	320	577	175.8	482
	CENTER	245	870	181.9	426	120	351
	WEST	307	833	146	317	119.5	330
8	EAST	401	591	178	324	116.6	187.6
	CENTER	265	496	118.8	278	82.5	162.5
	WEST	275	475	124.5	325	79	361
4	EAST	329	774	128	375	69.7	322
	CENTER	351	396	148.1	186.3	83.2	150.2
	WEST	187.9	423	102.9	371	75	147.8

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON GELATIN BLOCKS

16 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	796	1137	635	834	513	549
	CENTER	897	1339	547	774	492	507
	WEST	732	1434	697	860	438	595
12	EAST	577	881	343	419	263	379
	CENTER	578	1338	418	591	324	381
	WEST	465	817	287	510	214	349
8	EAST	440	645	330	306	197.1	285
	CENTER	339	396	311	333	292	271
	WEST	337	327	332	294	196.7	247
4	EAST	504	904	274	307	189.2	221
	CENTER	394	492	325	267	195.5	187
	WEST	323	309	311	227	182.2	226

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE COPPER LEACHATE BLOCK

19 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	1581	1287	1218	1170	900	919
	CENTER	1789	1498	1161	1068	746	553
	WEST	4030	2790	1489	1225	804	709
12	EAST	1049	1400	777	887	515	858
	CENTER	846	1283	598	782	512	614
	WEST	776	1339	573	845	394	533
8	EAST	380	1369	228	372	230	317
	CENTER	691	1053	370	419	297	362
	WEST	579	515	426	417	360	338
4	EAST	814	1019	374	432	182.6	313
	CENTER	704	848	399	472	269	306
	WEST	833	956	325	524	265	381

21 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	1057	1076	582	680	460	576
	CENTER	1302	1223	917	884	589	621
	WEST	1137	1691	1076	1145	739	1037
12	EAST	1054	5580	657	781	467	578
	CENTER	1047	1655	655	729	512	572
	WEST	961	1727	761	943	520	777
8	EAST	961	3840	592	570	422	450
	CENTER	910	1254	489	504	391	403
	WEST	768	1153	461	535	350	441
4	EAST	956	1593	455	630	329	406
	CENTER	741	1179	418	604	370	496
	WEST	574	1110	382	550	317	481

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE COPPER LEACHATE BLOCK

22 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	1900	11430	1487	1685	1312	1408
	CENTER	4350	6100	1602	1982	1028	1032
	WEST	4960	8460	4040	7090	3160	5370
12	EAST	1747	4980	1114	1750	1211	1265
	CENTER	1869	5160	1146	1753	900	914
	WEST	1811	5180	1100	1842	681	989
8	EAST	1525	6850	1298	1541	612	888
	CENTER	956	3700	586	981	484	600
	WEST	933	3900	914	1053	638	442
4	EAST	1580	2480	1035	1419	627	639
	CENTER	963	1674	710	942	441	481
	WEST	1057	1991	657	962	378	407

23 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	902	7960	1081	3850	6750	3170
	CENTER	5110	5090	3000	2960	947	3200
	WEST	3910	5270	3730	6540	1046	7880
12	EAST	1400	3310	830	952	484	873
	CENTER	4790	4100	937	1432	427	1010
	WEST	1848	5680	773	1369	491	979
8	EAST	1665	2720	596	949	440	704
	CENTER	4430	1610	750	793	417	652
	WEST	972	1658	642	977	379	746
4	EAST	729	3940	391	691	232	1041
	CENTER	705	1834	408	559	254	522
	WEST	623	1035	545	735	310	558

COMPARISON OF THE FIRST AND LAST DATA RUNS
OF EACH DAY ON THE COPPER LEACHATE BLOCK

24 AUG 85

DIST. APART (FT)		RESISTANCE 1/3 DEPTH FIRST	1/3 DEPTH LAST	1/2 DEPTH FIRST	1/2 DEPTH LAST	2/3 DEPTH FIRST	2/3 DEPTH LAST
16	EAST	8110	4560	4380	6760	2490	4260
	CENTER	6500	7790	4120	5450	1205	1377
	WEST	8070	8240	4440	5610	2420	2810
12	EAST	3600	1930	877	942	741	836
	CENTER	1929	3370	1052	1430	789	1047
	WEST	1372	4920	995	1429	843	992
8	EAST	2160	5720	593	983	503	652
	CENTER	690	1620	627	894	444	615
	WEST	685	1933	475	943	571	692
4	EAST	1930	1626	507	646	404	391
	CENTER	931	1405	519	710	367	455
	WEST	641	1432	435	701	408	493

Effect of Two Rod Sets on Data

Two different (8 inch) rod sets were used to conduct evaluations on all three gelatin blocks. A comparison of the two rod sets showed interesting results. The Mean Resistance Values for each rod set used to evaluate each gelatin block is found on pages IV-60 and IV-61 and graphed on IV-62, IV-63, and IV-64.

The study on the leachate gelatin block was performed with twenty-four data runs taken with rod set one and six with rod set two. The data for rod set one was consistantly lower at all stations and all probe spacings. Some overlaps in data occurred for both rod set one and rod set two during the leachate block evaluation, however, data from rod set two was much higher than data from rod set one.

The studies on the gelatin block and the copper leachate block involved eighteen data runs on rod set one and twelve data runs on rod set two. Rod set two was also found to produce higher resistance values at most of the thirty-six data recording locations for the gelatin and copper leachate blocks, however, the difference between the two sets of rods was approximately 20 percent. No overlap in data occurred for depth evaluations for the copper leachate studies and only one overlap occurred in the gelatin studies.

MEAN RESISTANCE VALUES FOR LEACHATE STUDIES
ROD SET1

RESISTANCE (OHMS)

DISTANCE APART (FEET)	1/3 DEPTH	1/2 DEPTH	2/3 DEPTH
16	413.9	247.7	322.1
12	234.7	137.4	124.7
8	169.5	102.3	88.5
4	132.5	78.8	66.7

ROD SET 2

RESISTANCE (OHMS)

DISTANCE APART (FEET)	1/3 DEPTH	1/2 DEPTH	2/3 DEPTH
16	1416	810.2	797.1
12	560	470.5	324.3
8	437.9	212.7	245.1
4	232.1	117.7	105.2

MEAN RESISTANCE VALUES FOR COPPER LEACHATE STUDIES
ROD SET 1

RESISTANCE (OHMS)

DISTANCE APART (FEET)	1/3 DEPTH	1/2 DEPTH	2/3 DEPTH
16	4139.6	3116.7	1587.7
12	2328	950.6	668.7
8	1521.4	594.2	443
4	1194	546.5	382.5

ROD SET 2

RESISTANCE (OHMS)

DISTANCE APART (FEET)	1/3 DEPTH	1/2 DEPTH	2/3 DEPTH
16	4123.4	2631.2	1816.1
12	3126.9	1063.6	724.9
8	2150	753.1	505.2
4	1400.9	662.8	389.8

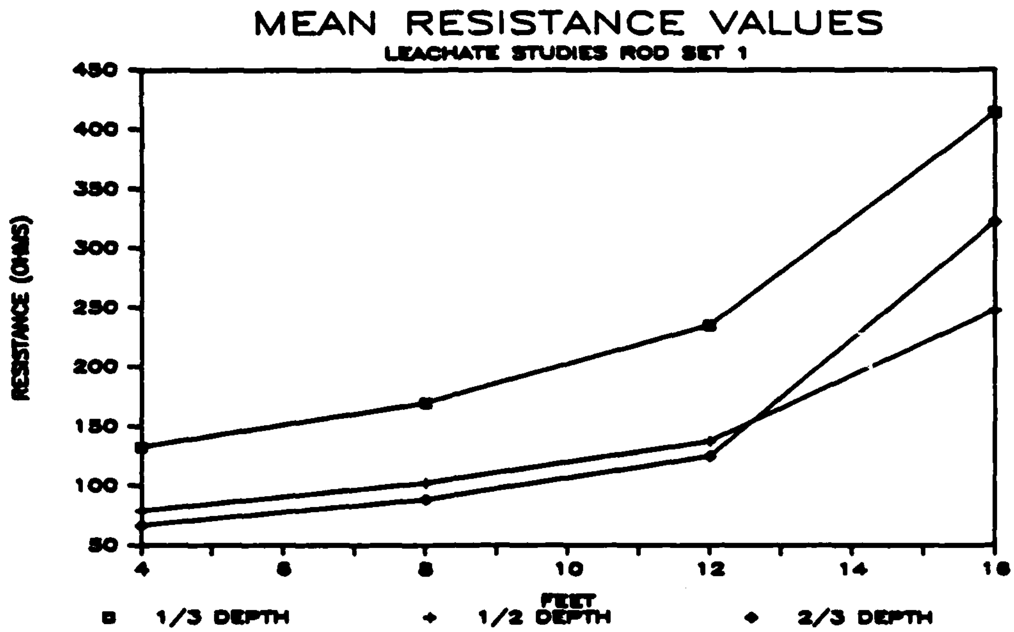
MEAN RESISTANCE VALUES FOR GELATIN STUDIES

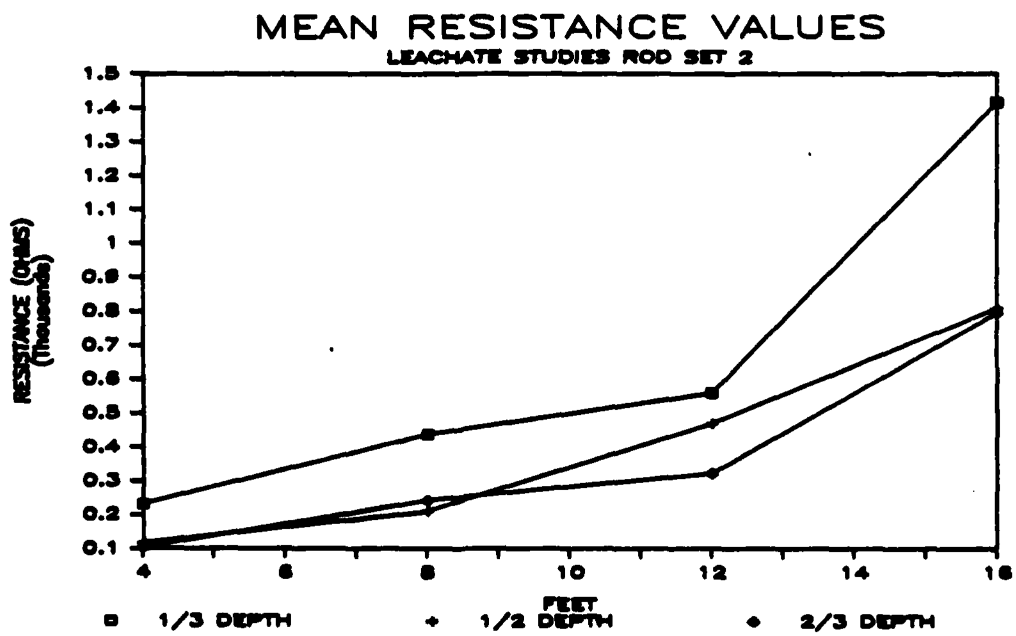
ROD SET 1

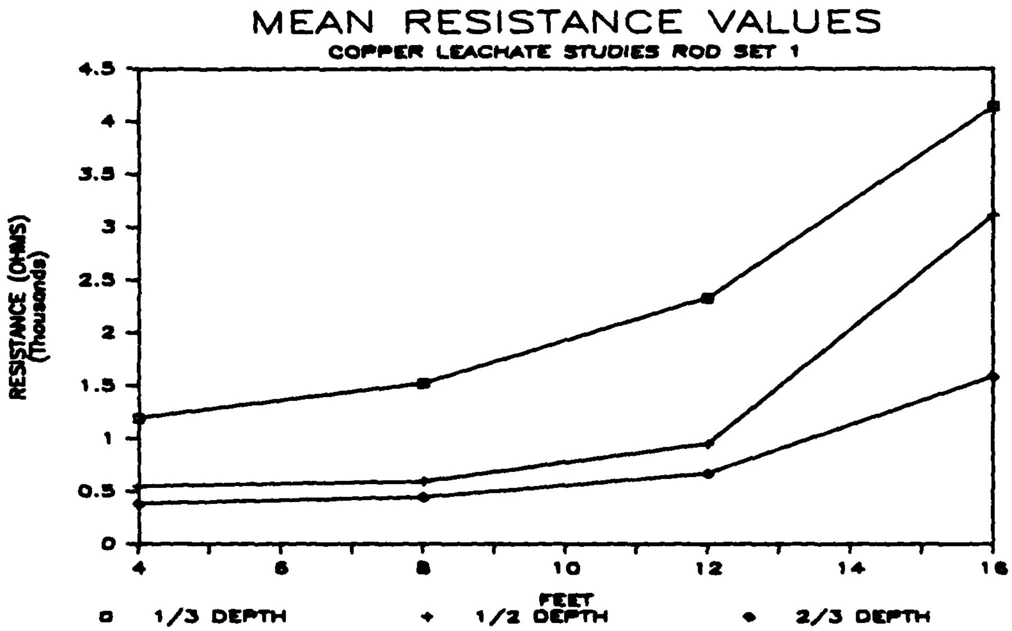
DISTANCE APART (FEET)	RESISTANCE (OHMS) 1/3 DEPTH	1/2 DEPTH	2/3 DEPTH
16	831.8	536	612.7
12	573.3	331.1	308.2
8	376.9	234.7	183.4
4	321.9	185.8	137

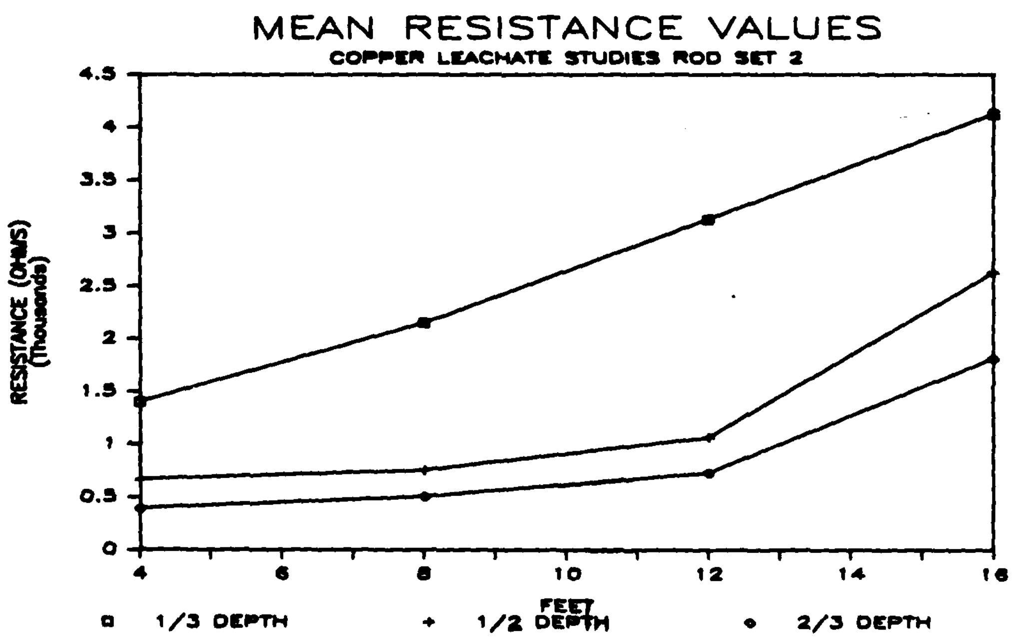
ROD SET 2

DISTANCE APART (FEET)	RESISTANCE (OHMS) 1/3 DEPTH	1/2 DEPTH	2/3 DEPTH
16	1090.5	590	477.5
12	687	416.6	349.3
8	450.3	282.2	241.1
4	383.2	226.5	196.5


MEAN RESISTANCE VALUES
LEACHATE STUDIES ROD SET 1
RESISTANCE (OHMS)
450
400
350
300
250
200
150
100
50
4
6
8
10
12
14
16
FEET
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH

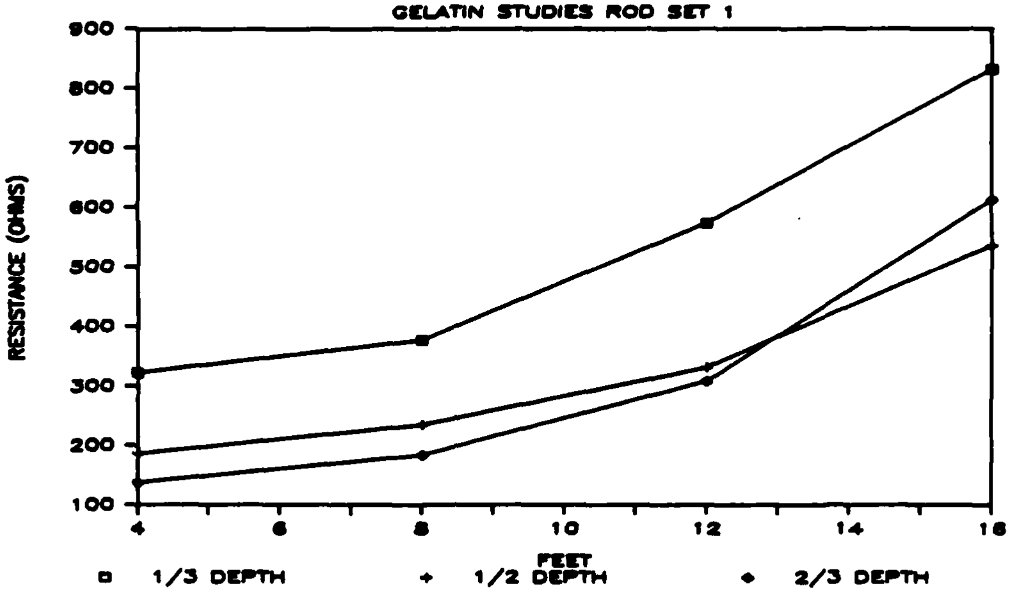

MEAN RESISTANCE VALUES
LEACHATE STUDIES ROD SET 2
RESISTANCE (OHMS)
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
4
6
8
10
12
14
16
FEET
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH


MEAN RESISTANCE VALUES
COPPER LEACHATE STUDIES ROD SET 1
RESISTANCE (OHMS) (Thousands)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4
6
8
10
12
14
16
FEET
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH


MEAN RESISTANCE VALUES
COPPER LEACHATE STUDIES ROD SET 2
RESISTANCE (OHMS) (Thousands)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4
6
8
10
12
14
16
FEET
1/3 DEPTH
1/2 DEPTH
2/3 DEPTH

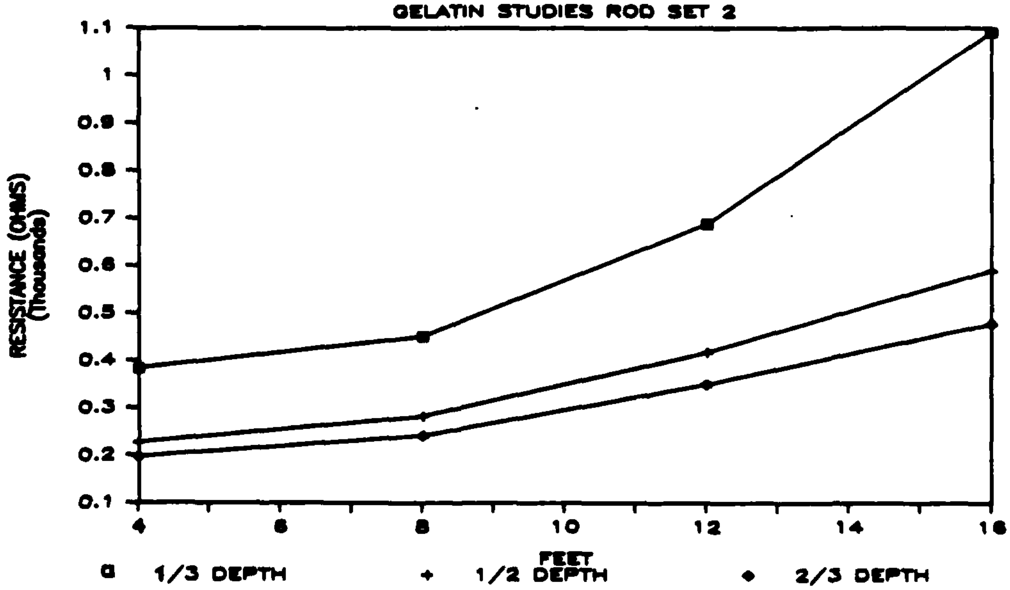
MEAN RESISTANCE VALUES

GELATIN STUDIES ROD SET 1



MEAN RESISTANCE VALUES

GELATIN STUDIES ROD SET 2



The graphs on pages IV-62, IV-63, and IV-64 illustrate a definable and repeatable pattern for probe pattern and spacing for all three gelatin studies. The complete data summary listing mean value, standard deviation, maximum and minimum values for both rod sets is found on pages IV-66 through IV-77.

The fact that only six data runs were taken with rod set two in the leachate gelatin evaluation, while twelve data runs were taken with rod set two on the gelatin block could account for the differences found in the data summaries for the gelatin and leachate gelatin studies. If six data runs were performed with a rod set that produces continually lower resistance values, then the resulting data summary would produce a lower mean for the data set. In short, the variation in the rod sets used to collect the data may have accounted for some of the difference between the leachate gelatin and gelatin blocks evaluated.

COMPARISON OF TWO ROD SETS LARGE TANK
GELATIN DATA ROD SET 1

1/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	18	1068.4	917.7	4640	373
	CENTER	18	775.8	295.2	1339	242
	WEST	18	651.2	249.1	1434	295
12	EAST	18	701.2	266.3	1344	319
	CENTER	18	607.5	393.0	1647	163
	WEST	18	411.2	181.0	817	130.9
8	EAST	18	509.0	146.2	745	192
	CENTER	18	345.9	135.5	656	124
	WEST	18	275.8	101.0	421	108.9
4	EAST	18	448.1	205.3	904	127
	CENTER	18	290.8	119.0	492	95.3
	WEST	18	226.8	104.0	462	95.3

1/2 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	18	588.4	238.4	1160	171
	CENTER	18	503.1	198.9	830	132.1
	WEST	18	516.4	229.9	882	141.2
12	EAST	18	349.0	116.1	555	120.6
	CENTER	18	341.7	162.2	642	103.2
	WEST	18	302.7	159.5	733	91.1
8	EAST	18	283.5	102.8	514	105.6
	CENTER	18	227.3	105.1	436	81.6
	WEST	18	193.2	81.4	338	79.2
4	EAST	18	221.4	106.7	464	91.2
	CENTER	18	179.2	80.5	331	63.1
	WEST	18	156.9	76.9	312	69.1

COMPARISON OF TWO ROD SETS LARGE TANK
GELATIN DATA ROD SET 1

2/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	18	1104.4	2326.8	10600	124.3
	CENTER	18	377.8	143.7	585	112.4
	WEST	18	395.9	169.0	673	119
12	EAST	18	424.7	306.7	1260	90.6
	CENTER	18	263.4	121.0	533	82.6
	WEST	18	236.4	105.3	431	79.2
8	EAST	18	227.6	101.9	418	79.4
	CENTER	18	173.4	75.8	331	75.4
	WEST	18	149.3	43.8	247	76.6
4	EAST	18	158.2	63.0	275	68.4
	CENTER	18	130.8	40.9	195.5	66.3
	WEST	18	122.0	44.6	226	66

COMPARISON OF TWO ROD SETS LARGE TANK
GELATIN DATA ROD SET 2

1/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	12	1723.3	1105.2	4080	772
	CENTER	12	816.0	192.3	1157	523
	WEST	12	732.3	220.8	1216	471
12	EAST	12	884.0	699.5	3140	443
	CENTER	12	682.7	305.5	1286	302
	WEST	12	494.3	192.1	878	225
8	EAST	12	627.7	219.4	1216	421
	CENTER	12	401.5	147.8	627	195.3
	WEST	12	321.7	125.5	576	169
4	EAST	12	531.1	271.7	1145	236
	CENTER	12	338.5	153.1	659	151
	WEST	12	280.0	105.6	454	124.6

1/2 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	12	626.0	212.2	1021	269
	CENTER	12	584.9	191.2	1007	292
	WEST	12	559.2	224.9	1066	216
12	EAST	12	394.9	116.0	577	223
	CENTER	12	505.5	475.3	1994	127
	WEST	12	349.5	155.7	599	134.8
8	EAST	12	329.1	105.3	463	162.1
	CENTER	12	291.5	156.5	636	84.2
	WEST	12	225.9	107.2	385	92.6
4	EAST	12	273.0	115.4	519	136.7
	CENTER	12	211.4	143.0	589	72.6
	WEST	12	195.1	95.9	371	79.7

COMPARISON OF TWO ROD SETS LARGE TANK
GELATIN DATA ROD SET 2

2/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	12	558.8	223.7	879	157
	CENTER	12	450.3	173.2	784	234
	WEST	12	423.5	185.3	758	194.1
12	EAST	12	441.1	195.2	955	140.6
	CENTER	12	300.6	148.8	590	116.9
	WEST	12	306.1	137.0	521	97.9
8	EAST	12	281.8	119.6	436	95.4
	CENTER	12	222.8	126.1	530	84.4
	WEST	12	218.6	127.3	495	81.8
4	EAST	12	274.8	171.5	743	78.2
	CENTER	12	153.7	81.1	310	62.2
	WEST	12	161.1	101.0	417	72.1

COMPARISON OF TWO ROD SETS LARGE TANK
LEACHATE DATA ROD SET 1

1/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV	MAX	MIN
16	EAST	24	536.6	447.1	1868	121.9
	CENTER	24	383.0	264.3	977	76.8
	WEST	24	322.2	221.0	769	82.1
12	EAST	24	322.8	180.7	644	97.6
	CENTER	24	215.5	154.6	579	65.7
	WEST	24	165.9	88.5	380	66.2
8	EAST	24	247.1	153.5	617	71.3
	CENTER	24	138.1	88.6	435	58.5
	WEST	24	123.4	80.5	376	59
4	EAST	24	191.9	116.2	496	74.5
	CENTER	24	108.9	49.8	295	61.2
	WEST	24	96.8	31.3	186	59.1

1/2 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV	MAX	MIN
16	EAST	24	244.5	173.4	639	64.2
	CENTER	24	296.8	259.2	961	61
	WEST	24	202.0	136.7	535	63.4
12	EAST	24	170.7	113.3	418	51.4
	CENTER	24	135.4	97.8	381	51.5
	WEST	24	106.3	53.7	282	53.5
8	EAST	24	120.0	76.9	348	53.7
	CENTER	24	95.0	39.5	188	49.6
	WEST	24	91.8	58.5	340	47.8
4	EAST	24	92.8	42.6	249	46.6
	CENTER	24	74.5	25.8	139.1	43
	WEST	24	69.0	19.3	131.2	41

COMPARISON OF TWO ROD SETS LARGE TANK
LEACHATE DATA ROD SET 1

2/3 DEPTH

	DIST APART (FEET)	DATA POINTS	MEAN	STD.DEV	MAX	MIN
16	EAST	24	535.2	1141.6	5820	55.7
	CENTER	24	216.7	213.1	1053	57.2
	WEST	24	214.3	194.1	803	56.9
12	EAST	24	157.2	126.2	536	44.8
	CENTER	24	114.0	75.2	301	47
	WEST	24	103.0	76.8	421	45.1
8	EAST	24	100.4	68.8	375	41
	CENTER	24	81.5	32.0	174.3	46.7
	WEST	24	83.7	58.2	342	47.5
4	EAST	23	74.6	27.6	168.7	41.8
	CENTER	24	65.1	21.1	129.2	40.3
	WEST	24	60.3	15.1	106.3	39.9

COMPARISON OF TWO ROD SETS LARGE TANK
LEACHATE DATA ROD SET 2

1/3 DEPTH

	DIST APART (FEET)	DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	6	3172.5	3450.9	8560	395
	CENTER	6	573.8	153.3	799	379
	WEST	6	501.7	74.3	622	403
12	EAST	6	895.3	703.5	2440	376
	CENTER	6	477.2	182.6	847	307
	WEST	6	307.4	106.0	450	182.3
8	EAST	6	595.6	350.0	1225	138.8
	CENTER	6	530.0	546.5	1725	142.2
	WEST	6	188.0	90.3	327	80.5
4	EAST	6	412.8	222.0	808	182.9
	CENTER	6	160.8	77.2	261	63.9
	WEST	6	122.7	55.4	192	52.3

1/2 DEPTH

	DIST APART (FEET)	DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	6	1822.7	3192.6	8960	312
	CENTER	6	300.3	103.7	390	151
	WEST	6	307.5	116.2	476	153.8
12	EAST	6	760.3	984.8	2940	79.5
	CENTER	6	422.0	231.1	814	105.8
	WEST	6	229.3	160.5	546	44.5
8	EAST	6	288.7	160.3	502	63.2
	CENTER	6	213.6	145.5	448	28.6
	WEST	6	135.8	71.3	247	35.2
4	EAST	6	172.5	103.9	375	60.9
	CENTER	6	98.4	52.0	160.2	35.6
	WEST	6	82.2	42.6	140.8	29.4

COMPARISON OF TWO ROD SETS LARGE TANK
LEACHATE DATA ROD SET 2

2/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	6	1778.5	3230.7	8990	74.8
	CENTER	6	260.2	121.1	394	69.5
	WEST	6	352.7	222.4	702	51.4
12	EAST	6	411.3	246.4	857	34.5
	CENTER	6	350.1	231.3	802	141.6
	WEST	6	211.6	170.8	549	24.2
8	EAST	6	362.5	288.6	810	32.3
	CENTER	6	231.2	181.4	539	20.3
	WEST	6	141.7	104.1	350	24.6
4	EAST	6	153.1	121.3	391	25.8
	CENTER	6	90.3	52.7	160.5	19
	WEST	6	72.3	40.7	131.8	21.7

COMPARISON OF TWO ROD SETS LARGE TANK
COPPER LEACHATE DATA ROD SET 1

1/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	18	3214.4	2471.7	8110	945
	CENTER	18	4089.1	2908.9	9740	1223
	WEST	18	5115.4	3552.2	11350	1137
12	EAST	18	2204.2	1227.6	5580	1049
	CENTER	18	2627.2	2351.6	11010	846
	WEST	18	2152.7	1380.7	4920	767
8	EAST	18	2265.9	1797.3	6950	380
	CENTER	18	1301.7	1015.9	4500	558
	WEST	18	996.7	419.5	1933	515
4	EAST	18	1427.3	659.1	3780	814
	CENTER	18	1198.2	759.8	4040	539
	WEST	18	956.5	332.4	1615	545

1/2 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	18	3076.9	3062.2	9250	464
	CENTER	18	2746.8	2391.5	6870	738
	WEST	18	3526.6	3019.0	8830	841
12	EAST	18	897.2	278.7	1556	568
	CENTER	18	986.1	436.5	1883	453
	WEST	18	968.4	381.8	1714	389
8	EAST	18	607.9	241.0	1123	228
	CENTER	18	587.1	218.7	1080	264
	WEST	18	587.6	217.8	949	287
4	EAST	18	570.2	206.1	1205	371
	CENTER	18	527.8	150.8	812	281
	WEST	18	541.5	208.9	1176	291

COMPARISON OF TWO ROD SETS LARGE TANK
COPPER LEACHATE DATA ROD SET 1

2/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	18	1706.3	1481.1	4300	370
	CENTER	18	996.3	686.0	3150	396
	WEST	18	2060.4	1926.2	8090	509
12	EAST	18	660.9	221.9	1021	339
	CENTER	18	686.4	271.7	1220	310
	WEST	18	658.7	257.9	1082	260
8	EAST	18	434.0	171.7	710	183.9
	CENTER	18	434.1	173.8	861	170.1
	WEST	18	460.8	185.4	809	165.8
4	EAST	18	361.0	109.6	564	182.6
	CENTER	18	382.6	106.2	562	183.9
	WEST	18	404.1	120.0	696	243

COMPARISON OF TWO ROD SETS LARGE TANK
COPPER LEACHATE DATA ROD SET 2

1/3 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	12	3820.7	2889.9	11430	836
	CENTER	12	4053.3	1263.9	6100	1289
	WEST	12	4496.3	1647.9	8460	1695
12	EAST	12	2804.3	1318.3	5280	1400
	CENTER	12	3332.1	1498.6	5660	1255
	WEST	12	3244.3	1385.1	5680	1502
8	EAST	12	2461.5	1450.0	6850	1249
	CENTER	12	2636.1	1525.8	5410	676
	WEST	12	1352.3	824.6	3900	409
4	EAST	12	1784.8	889.5	3940	729
	CENTER	12	1244.3	383.1	1866	705
	WEST	12	1173.7	421.4	1991	623

1/2 DEPTH

DIST APART (FEET)		DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	12	2108.1	1119.0	4000	631
	CENTER	12	1950.0	829.5	3260	1040
	WEST	12	3835.6	1647.8	7090	1317
12	EAST	12	1018.2	255.7	1750	795
	CENTER	12	1088.8	264.4	1753	659
	WEST	12	1083.8	302.9	1842	674
8	EAST	12	846.8	322.3	1541	358
	CENTER	12	704.6	167.2	981	278
	WEST	12	708.1	193.2	1053	291
4	EAST	12	765.2	324.0	1419	384
	CENTER	12	603.0	155.6	942	408
	WEST	12	620.3	167.0	962	307

COMPARISON OF TWO ROD SETS LARGE TANK
COPPER LEACHATE DATA ROD SET 2

2/3 DEPTH

	DIST. APART (FEET)	DATA POINTS	MEAN	STD.DEV.	MAX	MIN
16	EAST	12	1666.8	1660.1	6750	550
	CENTER	12	1145.4	661.3	3200	621
	WEST	12	2636.1	1975.3	7880	1019
12	EAST	12	864.3	275.2	1265	484
	CENTER	12	666.0	178.4	1010	427
	WEST	12	644.6	180.5	989	418
8	EAST	12	603.8	261.2	1225	239
	CENTER	12	455.6	99.8	652	251
	WEST	12	456.2	132.7	746	196.9
4	EAST	12	447.9	230.8	1041	189
	CENTER	12	355.3	100.0	522	214
	WEST	12	366.3	83.6	558	193

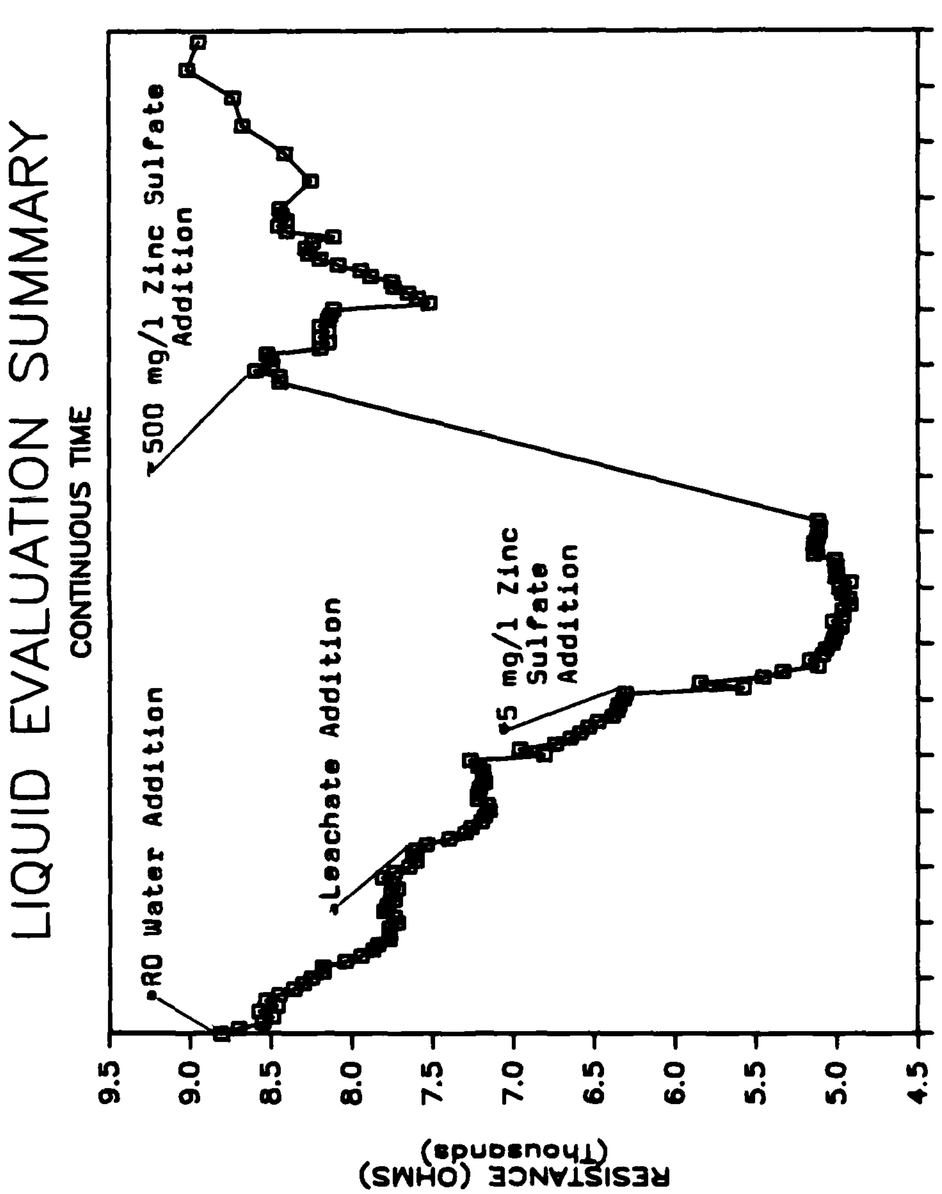
Liquid Contaminant Evaluations

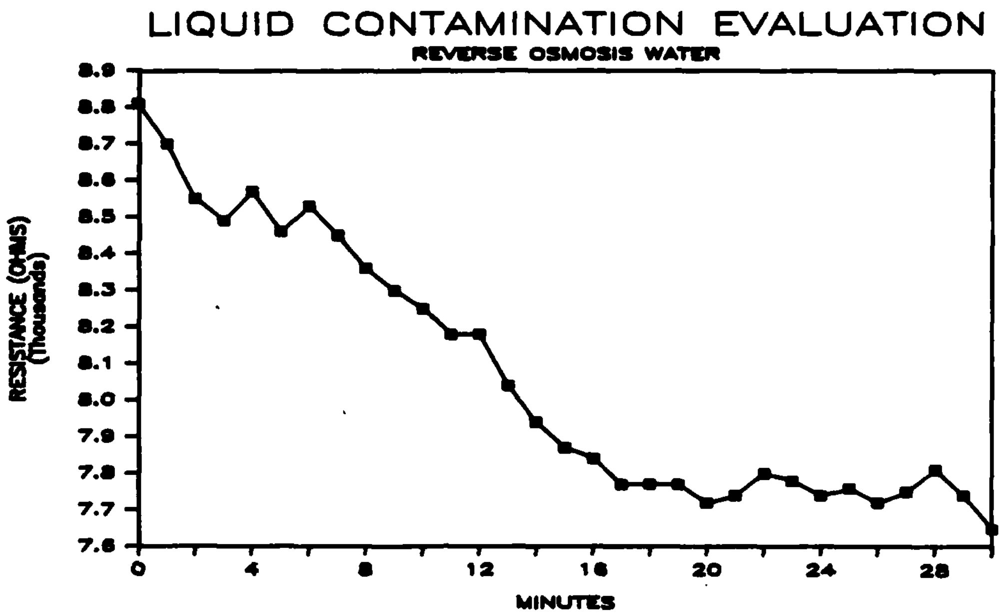
Liquid samples of reverse osmosis water, leachate, and two zinc sulfate spikes were added to the large tank and resistance data was collected at two stationary rod spacing and depth locations over a period of three hours. A summary graph of the four spike additions is found on page IV-79 with each individual plot graphed on pages IV-80 and IV-81. Data for these liquid contamination evaluations is found in Appendix 2 on pages A2-56 to A2-60.

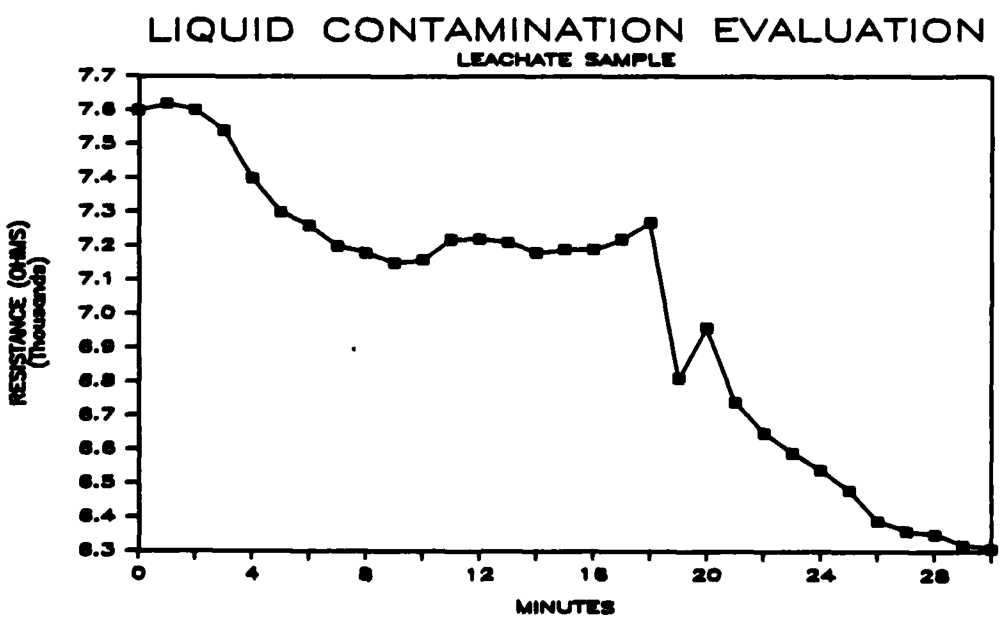
As the reverse osmosis water spike was added, the resistance value of the dry sand went from 10,730 Ω to 9,750 Ω after the addition of two liters of water. Two more liters of reverse osmosis water was added and the resistance of the two inner probes stablized at 7,650 Ω after thirty minutes.

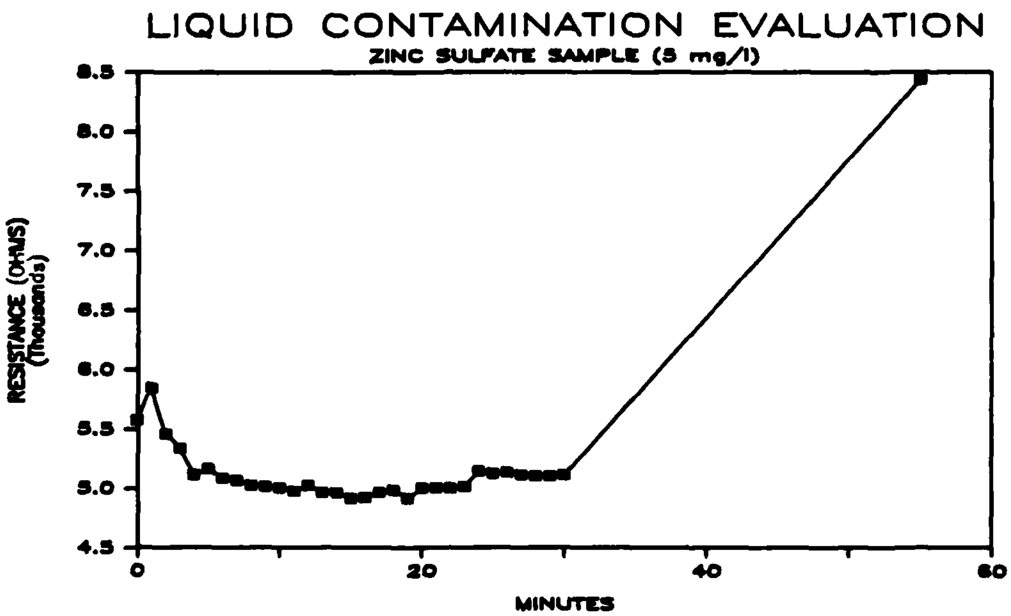
A leachate spike of approximately 800 ml was added, and the resulting resistance values dropped steadily from 7,600 Ω to 6,310 Ω after thirty additional minutes.

Next, a 5 mg/l zinc sulfate spike of 1500 ml was added to the tank and the resistance values dropped steadily from 5,580 Ω to 5,120 Ω over the next thirty minutes. However, fifty-five minutes after the zinc sulfate spike had been introduced to the tank, the

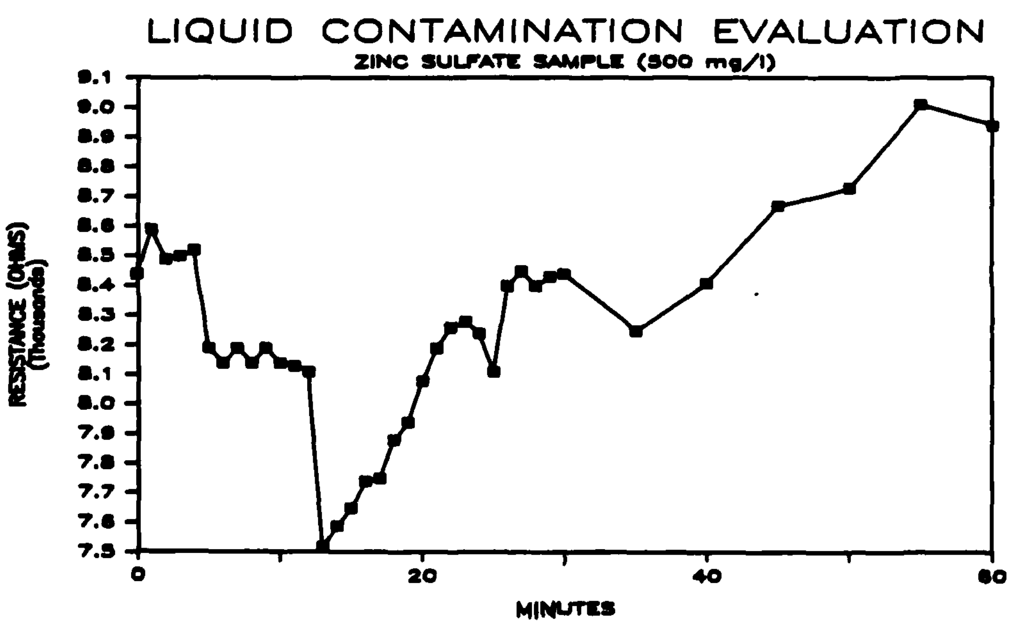

LIQUID EVALUATION SUMMARY
CONTINUOUS TIME
RESISTANCE (OHMS)
(Thousands)
MINUTES
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
0
20
40
60
80
100
120
140
160
180
RO Water Addition
Leachate Addition
5 mg/l Zinc
Sulfate
Addition
500 mg/l Zinc Sulfate
Addition


LIQUID CONTAMINATION EVALUATION
REVERSE OSMOSIS WATER
RESISTANCE (OHMS)
(Thousands)
8.9
8.8
8.7
8.6
8.5
8.4
8.3
8.2
8.1
8.0
7.9
7.8
7.7
7.6
0
4
8
12
16
20
24
28
MINUTES


LIQUID CONTAMINATION EVALUATION
LEACHATE SAMPLE
RESISTANCE (OHMS)
(Thousands)
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
6.4
6.3
0
4
8
12
16
20
24
28
MINUTES



LIQUID CONTAMINATION EVALUATION
ZINC SULFATE SAMPLE (5 mg/l)
RESISTANCE (OHMS) (Thousands)
MINUTES



LIQUID CONTAMINATION EVALUATION
ZINC SULFATE SAMPLE (500 mg/l)
RESISTANCE (OHMS) (Thousands)
MINUTES

resistance reading was up to 8,870 Ω, which was higher than after the addition of two liters of reverse osmosis water.

A final 500 mg/l zinc sulfate spike of 1500 ml was added to the tank and the resistance recorded. The resistance went from 8,440 Ω at the time of the 500 mg/l spike induction to 8,940 Ω at the end of one hour.

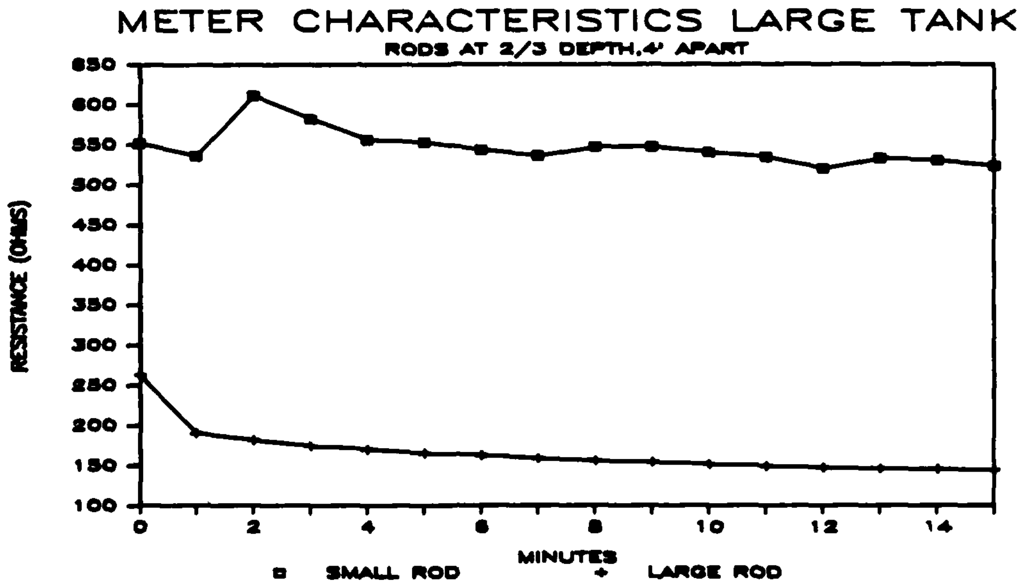
The relationship established with the gelatin blocks had been repeated with the liquid samples. The leachate addition resulted in a drop in the resistance data obtained. The liquid zinc sulfate spike had the same effect as the copper sulfate gelatin in that it showed a marked increased in the resistance values recorded. It was surprising, however, that the increase in resistance values took almost fifty-five minutes after initial addition to complete.

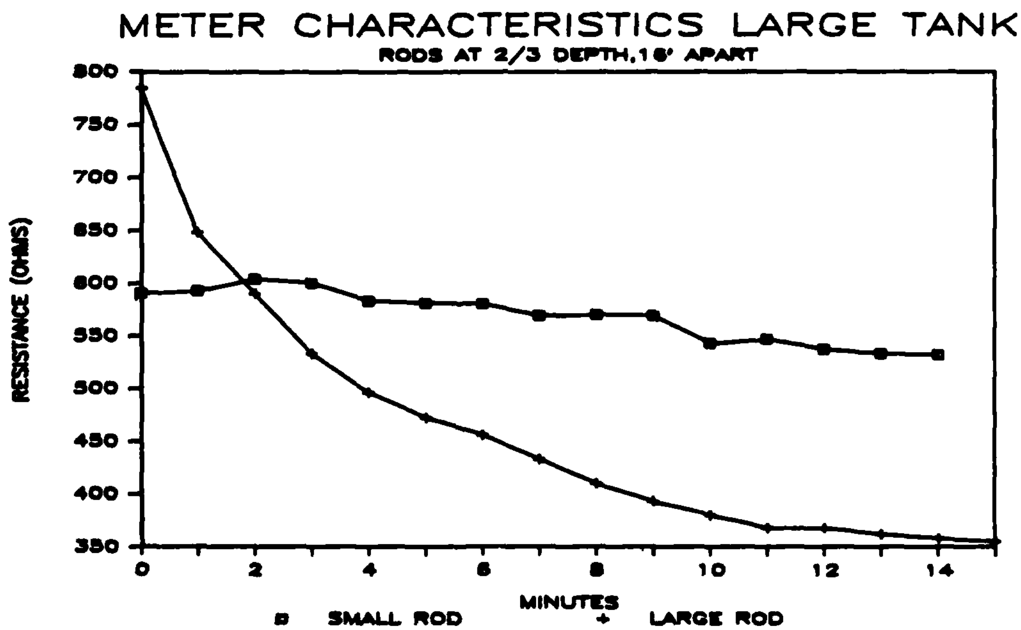
The 500 mg/l spike of zinc sulfate showed the same increasing trend in the resistance values, but after only about fifteen minutes. It is surmised that the liquid addition has an initial "wash out" effect upon the system and takes a period of time for the resistance reading to stablize again.

Meter Characteristics

The resistance values over time are shown in the graph on page IV-84 and the corresponding data on page A2-61. The data shows a characteristic drop in resistance as time increases. At approximately fifteen minutes, the resistance values were stabilized for each depth and spacing combination evaluated.

With this characteristic being the same for all readings taken, the one minute data recording value was shown to be "as equal" as any other recording time.


METER CHARACTERISTICS LARGE TANK
RODS AT 2/3 DEPTH,4' APART
RESISTANCE (OHMS)
MINUTES
SMALL ROD
LARGE ROD


METER CHARACTERISTICS LARGE TANK
RODS AT 2/3 DEPTH,16' APART
RESISTANCE (OHMS)
MINUTES
SMALL ROD
LARGE ROD

CHAPTER 5 - SUMMARY

The Resource Conservation and Recovery Act of 1976 has forced the identification, reporting, and correction of past waste management activities. There has been an increased need for improving present methods used to delineate and characterize areas of groundwater contamination.

The goal of this thesis was to evaluate the principles of electrical resistance and resistivity as they apply to subsurface mapping and contamination characterization.

Several studies were cited listing the current problems encountered in applying electrical resistivity data to contamination location and identification. These problems include lateral geologic variations, variable water table depth, variable soil saturation, man-made obstructions underground, small differences in resistivity values between contaminated and natural groundwater and overcoming threshold resistivity values for different soil types.

The experimental approach developed and used throughout this thesis was to eliminate as many of the aforementioned variables as possible to establish a definable relationship between electrical resistance data and contaminant identification.

The basic principles of electrical resistance used for subsurface mapping were defined in a small laboratory model. These principles were then used to identify specific gelatin contaminants in a large laboratory model.

Definable and repeatable relationships were established in both laboratory models. The data illustrated a definable correlation between resistance values and the type of contamination under study.

A summary of the studies conducted in the two laboratory models are listed in the Conclusions and Recommendations section.

Moisture content was the one major variable that could not be eliminated from this study. Variations in the daily moisture content was the single factor responsible for the high standard deviation of the data collected. Resistance values had a standard deviation of 100 percent at a 16 foot probe spacing and 30 percent at a 4 foot probe spacing.

Further electrical resistivity studies should be conducted on other contaminants at various saturation conditions, soil compactions, and soil compositions to establish resistivity-contamination relationships. These relationships will improve the current technology using electrical resistivity for the location and qualification of contamination plumes.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Definable and repeatable relationships between electrical resistance readings, probe spacing and probe depth were established in the small laboratory model.

2. Resistance studies on gelatin blocks in the small laboratory model showed leachate gelatin to have lower resistance values at all probe depths and spacings when compared to gelatin made from reverse osmosis water.

3. Resistance studies on gelatin blocks in the small model showed copper sulfate leachate gelatin to have much higher resistance values at all probe depths and spacings when compared either to reverse osmosis water gelatin or leachate gelatin.

4. The definable and repeatable relationships between resistance values, probe spacing and probe depth were reproduced in the large laboratory model.

5. Leachate gelatin under study in the large model produced lower resistance values at all probe depths and probe spacings than reverse osmosis water gelatin.

6. Copper sulfate leachate gelatin under study in the large model produced much higher resistance values

at all probe depths and probe spacings than either reverse osmosis water gelatin or leachate gelatin.

7. Liquid spikes of reverse osmosis water, leachate and zinc sulfate solutions produced the same characteristic resistance data as the gelatin blocks.

Recommendations

1. Electrical resistance (and resistivity) should be studied further to evaluate various saturation levels, soil compositions, soil compactions, and contamination concentrations to establish definable relationships between these variables and electrical resistivity data.

2. Moisture content must be controlled in future studies to obtain a better correlation between resistance data and contamination identification. This study showed that certain relationships existed, however, moisture variations eliminated the possibility of relating the data relationships to exact numerical interpretations.

CHAPTER 6 - FUTURE STUDIES

There are two broad areas for expansion in the development and use of electrical resistivity. First, continued emphasis on resistivity for the detection of underground contamination, and second, the specific application of electrical resistivity to access waste impoundment failures.

The results of the studies cited and the data presented here show that electrical resistivity is a valuable tool for the location and identification of contaminate plumes. The field method has shown considerable success in locating contaminants containing high concentrations of conducting ions.

The method has not proven as successful for locating and identifying areas where the geologic subsurface is not clearly defined. Further, the field method has not been successful in identifying pollutants with low concentrations of conducting ions which are masked by normal variations in background electrical resistivity values.

Currently, the success or failure of the Electrical Earth Resistivity Survey depends upon site specific factors, such as geologic variation, composition, moisture, and buried electrical interferences. In short, the more information known

about the site, the better the interpretation of the resistivity data.

The ultimate goal for resistivity surveys would be to develop a numeric relationship between resistivity data and the contaminant type and concentration. This relationship cannot be established until further laboratory models are designed to evaluate each variable that can affect the resistivity data. These laboratory models would allow each variable to be controlled or removed to establish the desired relationships.

A study by James Behan attempted to establish a relationship between field resistivity data and water quality data from on-site monitoring wells. A numeric correlation between water quality data and resistivity data was not found due to site specific interferences.

The results of this thesis point to the fact that resistance relationships do exist that would allow the identification of a contaminant as leachate or a metallic sulfate solution in a homogeneous sand model. This study did not develop a numeric relationship due to the variations in daily moisture content. Further, the data obtained in the large flume has no numeric meaning unless it can be compared to data from other studies with varied moisture concentrations, soil types and soil compactions.

Clearly, laboratory models evaluating each of these variables would expand the use of electrical resistivity data from the area of contaminant location into the areas of contaminant qualification and quantification.

Another area for future study is the use of electrical resistivity data to locate leaks in landfill liners. A project by Duff, Shultz and Peters found that resistivity data was capable of detecting small leaks of 1 inch in diameter to within 1 1/2 feet from the leak. They felt that the techniques could be used to survey the integrity of landfill liners.

A study by Davis and Waller evaluated several acoustic, electromagnetic and electric methods for detecting waste impoundment liner failures. Their results indicated that no single technique was able to detect liner failure or leachate leaks with absolute certainty. However, the advantages of using the electrical resistivity method include the relative low cost and the sensitivity of the instrument to small resistance changes.

Electrical resistivity is valuable as a liner detection system because background data is taken on the liner as it is installed. This data can then be used as a zero point for future data evaluations. As leaks occur or as the characteristics of the landfill

leachate change, the electrical resistivity data will show an overall variation from the zero point established.

The optimum system for evaluating electrical resistivity as a landfill liner leak detection system would be the installation of a permanent resistivity system in a small test landfill of known contents. Water quality data from monitoring wells located around this test landfill could be compared to the resistivity data taken. As changes in water quality are noted, a corresponding change in the resistivity data should occur. This would lead to contaminant quantification and qualification relationships.

APPENDIX 1

A1. Data Collected from Small Tank

Depth, Spacing, and Rod Length Relationships	A1-1-A1-6
Taped Rod Data	A1-7-A1-11
Paraffin Block Studies	A1-12-A1-16
Gelatin Block Studies	A1-17-A1-29
Meter Characteristics	A1-30-A1-32

Notes:

Resistance values in Ohms, unless otherwise stated.

OS means value was off scale for the meter.

SAT means moisture saturation.

SLIGHT means slight sand compaction.

HEAVY means heavy sand compaction.

INITIAL STUDY SMALL TANK
3" ROD

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 1"	3"
16	47	32
14	41	29
12	39	26
10	38	25
8	36	20
6	34	18.5
4	34	17
2	30	15

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 1"	3"
16	40	28
14	40	24
12	38	22
10	38	20
8	36	19.5
6	34	17
4	32	15
2	28	14.5

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 1"	3"
16	39	28
14	40	25
12	38	23
10	34	21
8	34	18.5
6	33	17
4	27	16
2	23	15

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 3"
16	24
14	22
12	20
10	18.5
8	17.8
6	16.5
4	14.5
2	13

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 3"
16	23
14	22
12	22
10	21
8	19.5
6	17.5
4	15.5
2	13

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 3"
16	28
14	26
12	23
10	20
8	19.5
6	17.5
4	15
2	13.5

DEPTH STUDIES SMALL TANK
3" ROD

DISTANCE APART (INCHES)	RESISTANCE (X 10K) DEPTH 1"	2"	DISTANCE APART (INCHES)	RESISTANCE (X 10K) DEPTH 1"	2"
16	4	2.1	16	4.25	1.6
14	3.25	1.4	14	4.5	1.3
12	3	1.75	12	3.5	1.6
10	3.25	1.4	10	3.5	1.5
8	3.25	1.4	8	3.5	1.3
6	2.75	1.1	6	3	1.2
4	2.5	1.5	4	3	1.5
2	2.75	1.1	2	3.25	1

DISTANCE APART (INCHES)	RESISTANCE (X 10K) DEPTH 1"	2"	DISTANCE APART (INCHES)	RESISTANCE (X 10K) DEPTH 1"	2"
16	3.5	1.6	16	4	1.4
14	2.75	1	14	3.5	1.25
12	3	1.6	12	3	1
10	3	1	10	3	1.2
8	2.75	1.1	8	2.75	1.1
6	2.25	1.25	6	2.25	1.25
4	2.1	1.4	4	2.75	0.75
2	2.25	0.9	2	2.5	1.5

INITIAL STUDY SMALL TANK
6" ROD

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 1"	6"	DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 1"	6"
16	39	28	16	40	23
14	40	26	14	38	26
12	37	25	12	42	25
10	37	22	10	40	25
8	34	20	8	40	[illegible]
6	37	18	6	40	20
4	36	17	4	35	18
2	32	15	2	26	16

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 1"	6"	DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 6"
16	40	31	16	32
14	38	27	14	29
12	35	25	12	[illegible]
10	35	24	10	28
8	33	20	8	26.5
6	33	19	6	24
4	30	17	4	22
2	24	15.5		

DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 6"	DISTANCE APART (INCHES)	RESISTANCE (OHMSX100) DEPTH 6"
16	32	16	[illegible]
14	30	14	30
12	30	12	[illegible]
10	29	10	30
8	27	8	[illegible]
6	25	6	[illegible]
4	21	[illegible]	[illegible]
16	32	16	[illegible]
14	30	14	[illegible]
12	28	12	28
10	26	10	[illegible]
8	24	8	24
[illegible]	21	6	[illegible]
[illegible]	[illegible]	4	[illegible]

DEPTH STUDIES SMALL TANK
6" ROD

DISTANCE APART (INCHES)	RESISTANCE (OHMS X 100) DEPTH 1"	2"	3"	4"	5"
16	110	105	55	30	18
14	115	100	50	28	16
12	105	85	58	30	16
10	100	80	55	26	15.5
8	110	85	55	28	13.5
6	115	72	60	31	14.5
4	110	62	47	27	13.5
2	110	62	58	20	12

DISTANCE APART (INCHES)	RESISTANCE (OHMS X 100) DEPTH 1"	2"	3"	4"	5"
16	120	90	52	29	17
14	120	90	55	26	15
12	115	85	60	25	14
10	115	75	50	22	14
8	130	65	55	23	4.[illegible]
6	120	80	60	24	12.5
4	115	70	44	21	[illegible]
2	115	70	42	22	[illegible]

DISTANCE APART (INCHES)	RESISTANCE (OHMS X 100) DEPTH 1"	2"	3"	4"	5"
16	115	100	55	27	[illegible]
14	105	90	47	21	[illegible]
12	105	85	58	26	[illegible]
10	105	68	65	23	[illegible]
8	110	100	65	24	[illegible]
6	110	2	42	21	15.[illegible]
4	110	68	48	18.5	[illegible]
2	105	75	43	18.5	[illegible]

DEPTH STUDIES SMALL TANK
6" ROD

DISTANCE APART (INCHES)	RESISTANCE (OHMS X 100) DEPTH 1"	2"	3"	4"	5"
16	130	115	60	24	19
14	140	90	49	22	.15.5
12	115	85	52	21	17
10	112	75	44	28	15.5
8	130	80	48	21	15.5
6	115	72	55	22	12
4	110	60	44	21	10.5
2	100	65	45	17	13

SMALL TANK OVERSATUATED CONDITIONS
6" ROD

DISTANCE APART (INCHES)	RESISTANCE (X 100 SCALE) DEPTH 1"	2"	3"	4"	5"
16	120	55	35	22	16
14	110	50	31	22	16
12	108	46	34	22	17
10	82	40	31	22	17.5
8	75	40	30	21	16.5
6	75	38	29	22	16
4	70	37	28	20	16.5
2	89	34	26	20	15.5

DISTANCE APART (INCHES)	RESISTANCE (X 100 SCALE) DEPTH 1"	RESISTANCE (X 10K SCALE) DEPTH 1"
16	200	2.5
14	300	3.25
12	300	2.5
10	200	2
8	200	1.75
6	190	1.9
4	180	1.9
2	180	1.25

RESISTANCE DATA FOR TAPED RODS

6"ROD,2"DEEP,2"TAPED		6"ROD,4"DEEP,2"TAPED	
DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)	DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	2.75	16	0.75
12	2.6	12	1
8	2.5	6	1.75
4	2.5	4	1.9
16	4.4	16	1
12	4.6	12	1.25
8	3.5	8	1.[illegible]
4	3.6	4	1.25
16	17	16	0.75
12	3.6	12	1.25
8	3.6	8	1.5
4	3.1	4	3.75
16	4	16	1
12	3.5	12	1.25
8	4.1	8	1.1
4	4.25	4	1.6

RESISTANCE DATA TAPED RODS

6"ROD,4"DEEP,4"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	1.4
12	4.6
8	1.5
4	1.4
16	1.6
12	1.4
8	1.4
4	1.4
16	1.4
12	1.4
8	1.5
4	1.1
16	1.4
12	1.5
8	1.4
4	1.4

6"ROD,1"DEEP,1"TAPED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	22
12	5.5
8	7.2
4	6.25
16	14.75
12	6.75
8	7.5
4	6.5
16	12.3
12	5.5
8	7.3
4	6.4
16	5.7
12	8.1
8	5.[illegible]
4	6.75

RESISTANCE DATA FOR TAPED RODS

6"ROD,2"DEEP'4"TAPED DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)	3"ROD,1"DEEP,2"TAPED DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	14.25	16	7.9
12	8.25	12	5.5
8	21	8	5.5
4	16.75	4	6.4
16	14.25	16	6.5
12	20	12	5.4
8	25	8	6.4
4	7	4	7.5
16	5.25	16	15.5
12	12	12	4.9
8	5.75	8	6.5
4	19.25	4	5.5
16	17	16	6.1
12	12.5	12	5.5
8	18	8	6.25
4	31	4	5.9

RESISTANCE DATA FOR TAPED RODS

6"ROD,2"DEEP,1"TAPED		3"ROD,2"DEEP,2"TAPED	
DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)	DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	4	16	3.9
12	2.5	12	2.6
8	2.75	8	2.5
4	3.6	4	3.5
16	2.75	16	10
12	3.25	12	2.9
8	3.4	8	2.9
4	4	4	4.5
16	3	16	3.1
12	4.5	12	2.25
8	3	8	2.5
4	4	4	3.25
16	2.9	16	3.5
12	2.8	12	2.75
8	3.6	8	3.1
4	4	4	4

RESISTANCE DATA FOR TAPED RODS AT DIFFERENT COMPACTIONS

3"ROD,2"DEEP,2"TAPED,LOOSE

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	5.5
12	4
8	3.5
4	3.4
16	2.8
12	3.1
8	3.6
4	3.75

3"ROD,2"DEEP,2"TAPED,COMPACTED

DISTANCE APART (INCHES)	RESISTANCE (X10K OHMS)
16	4.5
12	2
8	1.9
4	5
16	2.9
12	2.4
8	2.5
4	2.9

PARAFFIN STUDIES SMALL TANK
3" ROD

PARAFFIN CENTERED

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	DEPTH 2"
16	4.6	2
12	3.8	2.4
8	3.9	1.9
4	4	2.3

PARAFFIN 4" FROM LEFT WALL

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	DEPTH 2"
2	4.5	1.8
4	4	1.9
6	3.9	1.6
8	4	2.1
10	3.9	2

PARAFFIN WITH 12-1/4 INCH HOLES CENTERED

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	DEPTH 2"
16	4.8	2.1
12	3.6	2.1
8	3.4	1.9
4	3.6	2.3

PARAFFIN WITH 12-1/4 INCH HOLES 4" FROM LEFT WALL

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	DEPTH 2"
2	4.4	2.1
4	4	2
6	3.4	1.6
8	3.6	1.7
10	3.8	1.7

PARAFFIN STUDIES SMALL TANK
6" ROD

PARAFFIN CENTERED

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	1.75	1	0.5
12	1.9	1.25	0.6
8	1.75	0.9	0.4
4	2	1.1	0.5

PARAFFIN 4" FROM
LEFT WALL

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
2	2	0.75	0.5
4	2.25	0.9	0.6
6	1.75	0.9	0.6
8	2.1	1	0.75
10	2	1.1	0.75

PARAFFIN WITH 12-1/4 INCH
HOLES CENTERED

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	2.9	1.5	0.6
12	2	1.25	0.6
8	1.75	1.1	0.6
4	2.4	1.1	0.6

PARAFFIN WITH 12-1/4 INCH
HOLES 4" FROM LEFT WALL

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
2	2.75	1.25	0.6
4	2	1	0.6
6	2.1	1.25	0.75
8	2	1.1	0.6
10	1.9	1.1	0.75

PARAFFIN-SALT BLOCK STUDIES SMALL TANK
3" ROD

SALT BLOCK CENTERED

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
16	3.6	1.8
12	3.5	1.9
8	3.8	2.1
4	2.9	1.4
16	3.25	1.6
12	3.1	1.75
8	3	1.6
4	2.75	1.8
16	3.1	1.75
12	3.25	1.9
8	3.25	1.9
4	2.75	1.8
16	2.9	1.5
12	3.1	2
8	2.75	1.5
4	3	1.5
16	2.1	1.4
12	1.1	0.6
8	0.5	0.8
4	0.4	0.75
16	1.6	1
12	0.9	0.5
8	0.9	0.75
4	0.8	0.6

SALT BLOCK CENTERED
WITH HOLES
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
16	2.4	1.75
12	1.4	1
8	1.6	1.1
4	1.4	0.9
16	2.5	1.6
12	1.25	0.8
8	1.3	0.9
4	1.25	1.1
16	1.9	1.1
12	1	0.7
8	1.25	0.9
4	1.1	0.8
16	1.9	1.1
12	0.9	0.7
8	1.1	0.75
4	1	0.8

PARAFFIN-SALT BLOCK STUDIES SMALL TANK
6" ROD

SALT BLOCK CENTERED

RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	2.75	1.75	0.75
12	2.4	1.75	0.9
8	1.9	1	7.6
4	1.75	1	0.6
16	1.6	1	0.6
12	1.8	1.25	0.75
8	1.8	0.8	0.6
4	1.75	0.75	0.5
16	1.75	0.9	0.5
12	1.9	1	0.6
8	1.6	0.9	0.5
4	1.6	0.75	0.4
16	1.75	1	0.75
12	1.9	1	0.7
8	1.8	1	0.6
4	1.25	0.9	0.3
16	1.4	0.6	0.3
12	0.5	0.25	0.5
8	0.6	0.6	0.4
4	1.1	0.5	0.25
16	1	0.7	0.4
12	0.75	0.5	0.25
8	0.8	0.5	0.4
4	1	0.6	0.4

SALT BLOCK CENTERED
WITH HOLES
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	2.1	1.1	0.6
12	0.9	0.6	0.4
8	1	0.75	0.7
4	0.9	0.6	0.5
16	0.9	0.8	0.5
12	0.7	0.5	0.25
8	0.9	0.7	0.6
4	0.75	0.5	0.4
16	1.25	0.9	0.6
12	0.8	0.5	0.4
8	0.9	0.75	0.6
4	0.9	0.6	0.5

PARAFFIN-SALT BLOCK STUDIES SMALL TANK
6" ROD

TWO SALT BLOCKS CENTERED

RESISTANCE (X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	1	0.6	0.3
12	0.75	0.5	0.4
8	1.1	0.7	0.5
4	0.9	0.75	0.4
16	0.7	0.6	0.25
12	1	0.6	0.5
8	0.8	0.6	0.4
4	1	0.5	0.5

TWO SALT BLOCKS CENTERED
WITH HOLES
RESISTANCE (X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	1.25	0.8	0.4
12	0.75	0.4	0.3
8	0.8	0.6	0.6
4	0.5	0.4	0.3
16	1.2	0.75	0.5
12	0.75	0.5	0.3
8	0.8	0.6	0.5
4	0.6	0.4	0.3

PARAFFIN-SALT BLOCK STUDIES SMALL TANK
3" ROD

TWO SALT BLOCKS CENTERED

RESISTANCE (X10K)

DIST APART (IN)	DEPTH 1"	2"
16	1.6	1.8
12	1.1	0.6
8	1.25	0.8
4	1.1	0.8
16	1.5	1.25
12	1.25	1.25
8	1.5	1.4
4	1.25	0.8

TWO SALT BLOCKS CENTERED
WITH HOLES
RESISTANCE (X10K)

DIST APART (IN)	DEPTH 1"	2"
16	1.5	1.1
12	1	0.8
8	1.1	1.1
4	0.7	0.6
16	1.25	0.9
12	0.9	0.5
8	1	0.9
4	0.8	0.6

GELATIN BLOCK DATA SMALL TANK 6" ROD

DIST APART (IN)	14 JUN 85 10%SAT/SLIGHT DEPTH 2"	3"	4"	DIST APART (IN)	17 JUN 85 10%SAT/SLIGHT DEPTH 2"	3"	4"
12	OS	OS	OS	12	41.3	26.6	17.05
8	OS	OS	OS	8	29.8	17.04	14.94
4	27.8	19.5	32.8	4	30.5	27.6	OS
12	28.2	OS	OS	12	48.9	23	13.29
8	OS	16.42	19.07	8	135.1	13.06	12.77
4	OS	OS	OS	4	OS	OS	OS
12	OS	OS	OS	12	OS	OS	OS
8	29.6	17.83	OS	8	32.9	19.18	5700
4	OS	OS	OS	4	25.3	24.5	18.76
12	33.6	17.38	14.5	12	45	24.3	16.98
8	35	17.28	30.6	8	27.5	18.35	11.51
4	26.6	1035	OS	4	39.6	23.4	15.45
12	26.4	OS	OS	12	55.1	30.4	18.11
8	25.2	OS	10690	8	35	25.4	15.66
4	OS	OS	OS	4	26.7	21.8	17.6

GELATIN BLOCK DATA SMALL TANK 6" ROD

	18 JUN 85 10%SAT/SLIGHT				18 JUN 85 35%SAT/SLIGHT		
DIST APART (IN)	DEPTH 2"	3"	4"	DIST APART (IN)	DEPTH 2"	3"	4"
12	49.8	18.21	44.66	12	43.2	18.53	10.6
8	39.3	19.9	11.69	8	60.5	17.39	11.92
4	3710	26.2	19.4	4	37.4	20.8	12.45
12	40.3	27.4	12.81	12	30.1	17.74	11.02
8	51.1	27.7	15.14	8	36.2	18.19	9.44
4	47.1	20.7	16.2	4	57	25.2	14.64
12	37.3	27.5	11.61	12	32.8	15.8	10.89
8	37.1	16.4	10.89	8	56.4	20.4	12.73
4	29.6	16.85	10.52	4	34	20	11.13
12	56.2	22.1	11.8	12	46.5	24.9	14.49
8	52.4	30.9	12.08	8	50.7	22.7	12.15
4	45.5	19.4	10.04	4	40.6	24.8	09
12	48.4	23.6	12.97	12	50.9	22.4	12.87
8	40.5	21.8	11.8	8	43.3	17.8	13.91
4	32.9	18.56	10.61	4	46.8	27	13.21

COPPER BLOCK DATA SMALL TANK 6" ROD

DIST APART (IN)	14 JUN 85 10%SAT/SLIGHT DEPTH 2	3"	4"
12	OS	25.2	48
8	30	15.27	15.67
4	35.8	27	18.48
12	29.9	18.73	OS
8	23.3	18.1	14.99
4	24.9	16.77	OS
12	31.4	19.16	15.05
8	26.6	OS	OS
4	24	17.03	4170
12	28.8	17.14	14.55
8	23.3	15.01	11.93
4	18.1	OS	10.72
12	28.6	17.3	14.37
8	33.9	OS	78
4	21.2	14.84	11.11

DIST APART (IN)	14 JUN 85 10%SAT/SLIGHT DEPTH 2"	3"	4"
12	OS	25.2	48
8	30	15.27	15.67
4	35.8	27	18.48
12	29.9	18.73	OS
8	23.3	18.1	14.99
4	24.9	16.77	OS
12	31.4	19.16	15.05
8	26.6	OS	OS
4	24	17.03	4170
12	28.8	17.14	14.55
8	23.3	15.01	11.93
4	18.1	OS	10.72
12	28.6	17.3	14.37
8	33.9	OS	78
4	21.2	14.84	11.11

LEACHATE BLOCK DATA SMALL TANK 6" ROD

14 JUN 85
10%SAT/SLIGHT

DISTANCE APART (INCH S)	DEPTH 2	3"	4"
12	OS	OS	OS
8	OS	OS	OS
4	27.8	19.51	32.8
12	28.2	OS	OS
8	OS	16.43	19.07
4	OS	OS	OS
12	OS	OS	OS
8	29.6	17.83	OS
4	OS	OS	OS
12	33.6	17.38	14.5
8	35	17.28	30.6
4	26.6	1035	OS
12	26.4	OS	OS
8	25.2	OS	10690
4	OS	OS	OS

NOTE: OS MEANS OFF SCALE

COPPER BLOCK DATA SMALL TANK
3" ROD

DISTANCE APART (INCHES)	14 JUN 85 10%SAT/SLIGHT DEPTH 1"	2"
12	31.4	18.7
8	21.9	11.8
4	30.7	18.5
12	30.4	13.9
8	25.2	12.9
4	28.7	10.2
12	27.4	16.7
8	23.9	14.5
4	25.7	6.5
12	32.2	9.3
8	22.8	12.9
4	20.6	8.6
12	28.1	18.8
8	33.3	10.7
4	111	38.7

DISTANCE APART (INCHES)	14 JUN 85 10%SAT/SLIGHT DEPTH 1"	2"
12	31.4	18.7
8	21.9	11.8
4	30.7	18.5
12	30.4	13.9
8	25.2	12.9
4	28.7	10.2
12	27.4	16.7
8	23.9	14.5
4	25.7	6.5
12	32.2	9.3
8	22.8	12.9
4	20.6	8.6
12	28.1	18.8
8	33.3	10.7
4	111	38.7

COPPER BLOCK DATA SMALL TANK
3" ROD

DISTANCE APART (INCHES)	18 JUN 85 25%SAT/SLIGHT DEPTH 1"	2"	DISTANCE APART (INCHES)	18 JUN 85 25% SAT/HEAVY DEPTH 1"	2"
12	64.2	43.4	12	55.4	32.3
8	62.5	53.7	8	50.5	24.4
4	59.5	36.5	4	47.4	24.5
12	78.5	47.8	12	40.5	25.5
8	62.7	36.4	8	44.5	28.4
4	56.1	32.3	4	44.6	24.1
12	67.7	37.5	12	46.6	29.4
8	57.1	46.3	8	46.7	23
4	54.2	34.9	4	45	21.4
12	66.7	36.9	12	65.3	37.7
8	52.6	38.5	8	50.8	29.4
4	56.3	30.6	4	43.7	[illegible]
12	74.2	41.4	12	56.5	[illegible]
8	62.3	45	8	48.9	[illegible]
4	54.5	28.6	4	46.1	[illegible]

COPPER BLOCK DATA SMALL TANK
3" ROD
20 JUN 85
10%SAT/SLIGHT

DISTANCE APART (INCHES)	DEPTH 1"	DEPTH 2"
12	63.2	39.8
8	40.8	33.7
4	35.9	27.6
12	49.2	31.5
8	41.6	27.5
4	37	26.7
12	48.4	30.4
8	38.1	28.8
4	37.1	24.7
12	44.2	25.4
8	38.2	22
4	33.5	23
12	46.8	25.6
8	43.7	26.7
4	38.3	21.6

GELATIN BLOCK DATA SMALL TANK
3" ROD

DISTANCE APART (INCHES)	18 JUN 85 35%SAT/SLIGHT DEPTH 1"	2"
12	OS	31.9
8	OS	OS
4	82.2	39.5
12	75.1	35.3
8	76.6	38.1
4	83.2	37.5
12	89	54.9
8	104.2	38.8
4	95.3	35.9
12	93.9	34.9
8	90.7	43.1
4	111.9	40.7
12	110.9	46.9
8	106.2	44.5
4	108.5	46.6

DISTANCE APART (INCHES)	20 JUN 85 10%SAT/SLIGHT DEPTH 1"	2"
12	70.2	47.4
8	62.9	41.6
4	54.1	51.4
12	82.2	57
8	72.8	48.2
4	66.4	52.2
12	80.3	55.6
8	70	53.5
4	62.6	44.1
12	75.9	45
8	70.9	48.3
4	63.7	43.7
12	92.1	62.4
8	73.8	51.2
4	73.7	51.9

DISTANCE APART (INCHES)	18 JUN 85 35%SAT/SLIGHT DEPTH 1"	2"
12	84.8	44.1
8	71	38.4
4	65.4	39.2
12	85.4	46.2
8	65	33.4
4	52.7	32.6
12	86.7	55.2
8	62	29.6
4	51.9	27.3

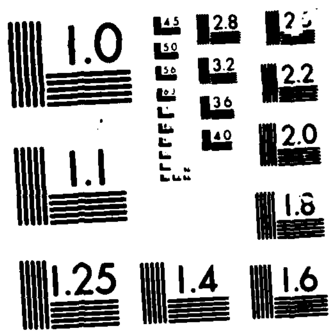
GELATIN BLOCK DATA SMALL TANK
3" ROD

DISTANCE APART (INCHES)	18 JUN 85 25%SAT/SLIGHT DEPTH 1"	2"
12	89.8	42.9
8	91	52
4	94.3	57.1
12	87.4	48.2
8	85.1	32.5
4	81.2	43.4
12	88	37.2
8	94.9	41.7
4	81.2	41.6
12	91.8	54.3
8	89.8	39.9
4	89.7	40.4
12	91.4	65.4
8	105.7	56.8
4	97.8	34

DISTANCE APART (INCHES)	18 JUN 85 25%SAT/HEAVY DEPTH 1"	2"
12	85.7	33.2
8	64.3	34.8
4	55.5	32.4
12	83.9	42.7
8	64	38.1
4	53.6	33.6
12	81.7	41.7
8	64	38.7
4	58.6	31.3
12	88.8	53.3
8	66.7	41.4
4	58.4	27.6
12	60.3	29.4
8	59.2	32.7
4	52.4	27.5

AD-A166 405 STUDY OF ELECTRICAL RESISTIVITY ON THE LOCATION AND IDENTIFICATION OF CONTAMINATION(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH B D MCCARTY 1985 3/3

UNCLASSIFIED AFIT/CI/NR-86-14T F/G 20/3 NL



MICROCOPY RESOLUTION TEST CHART

LEACHATE BLOCK DATA SMALL TANK
3" ROD

DISTANCE APART (INCHES)	14 JUN 85 10%SAT/SLIGHT DEPTH 1"	2"	DISTANCE APART (INCHES)	18 JUN 85 25%SAT/SLIGHT DEPTH 1"	2"
12	9.64	37.2	12	28.7	18.25
8	60.4	16.8	8	26.6	18.12
4	43	9.7	4	22.2	15.98
12	53	14.4	12	49.5	34.8
8	40.4	7.8	8	405	28.1
4	41.8	12.8	4	40.7	20.9
12	46	10.2	12	61.1	29.8
8	22.3	20.3	8	44.2	24.3
4	31.2	6.7	4	46.4	17.8
12	30.1	7.9	12	61.6	28.1
8	24.7	4	8	51.5	31.7
4	26.4	5.7	4	57.8	32.4
12	30.5	10.5	12	38.1	33.1
8	20	OS	8	45.2	26.9
4	28.1	6	4	50	29.1

LEACHATE BLOCK DATA SMALL TANK
3" ROD

	18 JUN 85 25%SAT/HEAVY			20 JUN 85 10%SAT/SLIGHT	
DISTANCE APART (INCHES)	DEPTH 1"	DEPTH 2"	DISTANCE APART (INCHES)	DEPTH 1"	DEPTH 2"
12	36.3	20.3	12	69.1	31.9
8	38.4	19.69	8	60.2	39.9
4	40	19.2	4	55.3	39.5
12	54.8	27.2	12	64.4	38.5
8	43.8	20.7	8	51.2	39.1
4	38.1	18.7	4	52.9	34.3
12	35.4	22.4	12	62	33.5
8	37.3	22.8	8	42.7	34.1
4	41.1	16.6	4	44.9	28.7
12	58.4	36.1	12	52.6	27.6
8	43.6	22.6	8	47.7	35.3
4	47.2	20.6	4	44.1	30.6
12	43.3	19.04	12	61.7	33.9
8	38.2	17.84	8	51.0	34
4	47.3	22.6	4	42	27.3

GELATIN STUDIES SMALL TANK 6" ROD

GELATIN CENTERED
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
16	3.75	3.5	1.1
12	2.75	2.9	0.9
8	3	3	1.25
4	3	3	1.1
16	2.5	2.25	1
12	2.1	1.75	0.75
8	2.25	1.9	1
4	2.6	2.25	1
16	2.75	2	1
12	2	1.5	0.75
8	2.5	1.9	1.1
4	3	2	1

GELATIN 4"LEFT WALL
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 2"	3"	4"
2	2.5	1.75	1.1
4	2.25	1.75	1.25
6	2	1.75	0.75
8	2	1.5	1
10	2	1.4	1.25
2	2	1.25	0.75
4	2	1.5	0.9
6	2	1.6	0.75
8	2.5	1.6	0.9
10	2.75	1.5	1
2	2.6	1.4	0.75
4	2.1	1.25	0.75
6	2.5	1.25	0.3
8	2.4	1.4	0.9
10	2.9	1.3	0.9

GELATTN STUDIES SMALL TANK 3" ROD

GELATIN CENTERED
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
16	11	2.75
12	10.5	2.4
8	9.5	2.75
4	8.5	3.5
16	7.5	4.25
12	7.5	3
8	6	3.4
4	5.25	3.25
16	5.75	2.5
12	5.5	3
8	6.5	3
4	6	3.75

GELATIN 4" LEFT WALL
RESISTANCE(X10K)

DIST APART (IN)	DEPTH 1"	2"
2	7.5	3
4	5.9	3.25
6	5.5	3.25
8	6.4	3.4
10	5	4.5
2	5.1	2.3
4	4.75	2.25
6	4	2.4
8	4.25	2.9
10	4.6	2.6
2	4.25	2
4	5	2.1
6	4.6	2.3
8	4.5	2.3
10	4.1	2.25

GELATIN BLOCK DATA SMALL TANK
3" ROD

DISTANCE APART (INCHES)	14 JUN 85 10%SAT/SLIGHT DEPTH 1"	2"	DISTANCE APART (INCHES)	17 JUN 85 10%SAT/SLIGHT DEPTH 1"	2"
12	9.64	37.2	12	108	77.4
8	60.4	16.8	8	90.3	45.1
4	43	9.7	4	82.2	46.5
12	53	14.4	12	93	64.7
8	40.4	7.8	8	76	43.5
4	41.8	12.8	4	73	48.3
12	46	10.2	12	74.4	57.4
8	22.3	20.3	8	70.2	46.2
4	31.2	6.7	4	67.2	38.7
12	30.1	7.9	12	71.9	41.8
8	24.7	4	8	67.4	34.6
4	26.4	5.7	4	63.4	42.2
12	30.5	10.5	12	71	39.1
8	20	OS	8	74.2	33.8
4	28.1	6	4	71.9	33.6

METER CHARACTERISTICS SMALL TANK

6"ROD,3"DEEP,8"APART

TIME (MIN)	RESISTANCE (OHMS)
0	12
1	8.5
2	8.66
3	8.58
4	8.36
5	8.24
6	8.04
7	7.82
8	7.67
9	7.47
10	7.32

6"ROD,4"DEEP,12"APART

TIME (MIN)	RESISTANCE (OHMS)
0	16.1
1	16.8
2	16.5
3	16.1
4	15.6
5	15.1
6	14.6
7	14.2
8	13.7
9	13.4
10	13.2

6"ROD,3"DEEP,6"APART

TIME (MIN)	RESISTANCE (OHMS)
0	11.3
1	10.24
2	10.34
3	10.46
4	10.62
5	10.78
6	10.92
7	11.03
8	11.12
9	11.11
10	11.18

6"ROD,4"DEEP,8"APART

TIME (MIN)	RESISTANCE (OHMS)
0	7.79
1	8.31
2	9.97
3	10.2
4	11.33
5	11.35
6	11.44
7	11.48
8	11.45
9	11.5
10	11.53

3"ROD.2"DEEP,8"APART

TIME (MIN)	RESISTANCE (OHMS)
0	50.2
1	30.2
2	23.1
3	16.8
4	12.6
5	9.5
6	6.6
7	5.5
8	4.4
9	4
10	4.1

METER CHARACTERISTICS SMALL TANK
DATA OF RESISTANCE-VS-TIME
6"ROD, 2"DEEP, 4"APART

TIME (MIN)	RESISTANCE (OHMS)	TIME (MIN)	RESISTANCE (OHMS)
1	20.4	40	32.9
10	34.2	41	32.7
15	35.6	42	32.6
20	36	43	32.4
22	35.5	44	32.5
23	35.3	45	32.2
24	35.2	46	32.3
25	34.7	47	32.6
26	34.7	48	32.6
27	34.2	49	32.7
28	34.2	50	32.8
29	34	51	32.3
30	33.8	52	31.9
31	33.7	53	31.9
32	33.5	54	31.5
33	33.5	55	31.5
34	33.4	56	31.3
35	33.3	57	31.3
36	33.2	58	31
37	33	59	31.1
38	32.9	60	31
39	32.9		

6"ROD,2"DEEP,8"APART

TIME (MIN)	RESISTANCE (OHMS)
0	28.7
1	26.1
2	23.2
3	21.4
4	19.7
5	18.5
6	17.8
7	17
8	16.5
9	15.7
10	15.2

6"ROD,2"DEEP,4"APART

TIME (MIN)	RESISTANCE (OHMS)
0	11.29
1	11.91
2	11.69
3	11.22
4	12.36
5	11.69
6	12.35
7	12.02
8	12.07
9	11.94
10	12.07

METER CHARACTERISTICS SMALL TANK
DATA OF TIME-VS-RESISTANCE

6"ROD, 3"DEEP, 6" APART

TIME (MIN)	RESISTANCE (OHMS)	TIME (MIN)	RESISTANCE (OHMS)
1	23.8	31	32.4
2	27.1	32	32.1
3	29.5	33	31.8
4	31.2	34	31.5
5	32.1	35	31.1
6	33.7	36	30.8
7	33.2	37	30.5
8	33.5	38	30.2
9	33.9	39	29.9
10	34.1	40	29.6
11	34.3	41	29.1
12	34.3	42	28.6
13	34.5	43	28.5
14	34.8	44	28.3
15	34.9	45	28
16	35.1	46	27.4
17	35.2	47	27.2
18	35.3	48	27
19	34.9	49	26.2
20	34.7	50	26
21	34.9	51	25.7
22	34.6	52	25.7
23	34.5	53	25.5
24	34.4	54	25.3
25	33.9	55	25.3
26	33.8	56	25.2
27	33.5	57	25.2
28	33.4	58	25.3
29	33	59	24.4
30	32.7	60	24.1

APPENDIX 2

A2. Data Collected from Large Tank

Initial Gelatin Studies	A2-1-A2-10
Leachate Gelatin Data	A2-11-A2-25
Reverse Osmosis Gelatin Data	A2-26-A2-40
Copper Leachate Gelatin Data	A2-41-A2-55
Liquid Contaminant Evaluations	A2-56-A2-60
Meter Characteristics	A2-61
Moisture Content Summaries	A2-62-A2-64
Evaporation Studies	A2-65-A2-68
Gelatin Loss	A2-69

Notes:

Resistance values are in Ohms, unless otherwise stated.

Scale refers to meter scale.

GELATIN STUDIES LARGE TANK 16 JUL 85
SMALL ROD
TRIAL RUN 1

DIST (FT)	1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16 EAST	98.7	200	83.6	200	181	2000
CENTER	91	200	221	2000	315	2000
WEST	63.3	200	35.8	200	28.7	200
12 EAST	145.8	200	104.2	200	177.3	200
CENTER	33.3	200	29.7	200	30	200
WEST	25.6	200	15.8	200	16.1	200
8 EAST	106.7	200	42.6	200	31.9	200
CENTER	45.9	200	27.1	200	29	200
WEST	40.2	200	23.4	200	15.7	200
4 EAST	31.1	200	38.0	200	18.1	200
CENTER	47.2	200	22.1	200	15.9	200
WEST	40.7	200	18.9	200	7.8	200

LARGE ROD
TRIAL RUN 2

DIST (FT)	1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16 EAST	184.3	2000	727	2000	[illegible]	[illegible]
CENTER	213	2000	1204	2000	1100	[illegible]
WEST	61.9	200	161.2	200	[illegible]	200
12 EAST	45.1	2000	1790	2000	[illegible]	[illegible]
CENTER	1502	2000	1126	2000	[illegible]	[illegible]
WEST	[illegible]	200	23	200	[illegible]	[illegible]
8 EAST	78.3	200	19.4	200	[illegible]	[illegible]
CENTER	32.9	200	62.8	200	[illegible]	[illegible]
WEST	21.6	200	46.5	200	[illegible]	200
4 EAST	[illegible]	200	[illegible]	200	[illegible]	[illegible]
CENTER	[illegible]	200	13.4	200	[illegible]	[illegible]
WEST	[illegible]	200	[illegible]	[illegible]	[illegible]	[illegible]

GELATIN STUDIES LARGE TANK 18 JUL 85
SMALL ROD
TRIAL RUN 3 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	3180	20 M	729	2000	317	2000
	CENTER	329	2000	290	2000	193.9	200
	WEST	269	2000	166.1	200	127.6	200
12	EAST	501	2000	154.3	200	104.2	200
	CENTER	138.6	200	110.4	200	81.6	200
	WEST	91.5	200	69.8	200	61.9	200
8	EAST	151.4	200	77.9	200	67.7	200
	CENTER	100.9	200	84	200	67	200
	WEST	95.4	200	61.6	200	54.5	200
4	EAST	386	200	79.6	200	55.3	200
	CENTER	95.1	200	58.9	200	61.3	200
	WEST	84.8	200	67.9	200	60.6	200

LARGE ROD
TRIAL RUN 4 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	266	2000	742	2000	282	2000
	CENTER	169	2000	407	2000	210	2000
	WEST	160.7	200	106.8	200	[illegible]	200
12	EAST	117.5	200	98.4	200	[illegible]	200
	CENTER	74.1	200	57	200	[illegible]	200
	WEST	62.7	200	48.7	200	[illegible]	200
8	EAST	81.3	200	48.7	200	[illegible]	200
	CENTER	68	200	64.5	200	55.7	200
	WEST	63.5	200	43.5	200	[illegible]	200
4	EAST	112.9	200	74.5	200	[illegible]	200
	CENTER	60.3	200	[illegible]	200	[illegible]	200
	WEST	61.1	200	48.1	200	[illegible]	[illegible]

GELATIN STUDIES LARGE TANK 20 JUL 85
SMALL ROD
TRIAL RUN 5 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	80	2000	134	2000	200	2000
	CENTER	160	2000	127.5	200	125.[illegible]	200
	WEST	323	2000	80.1	200	75.3	200
12	EAST	153	2000	137.8	200	106.7	200
	CENTER	155.5	200	96.8	200	86.1	200
	WEST	153.8	200	87.8	200	67.9	200
8	EAST	294	2000	102.7	200	73.4	200
	CENTER	100.1	200	70.[illegible]	200	53.1	200
	WEST	81.4	200	68.5	200	51.9	200
4	EAST	217	2000	81.4	200	50.[illegible]	200
	CENTER	124.1	200	63.3	200	55.7	200
	WEST	101.7	200	69.9	200	49.3	200

LARGE ROD
TRIAL RUN 6 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	171	2000	171	200	[illegible]	[illegible]
	CENTER	151	2000	160.5	200	107.5	200
	WEST	91.8	200	63.2	200	79	200
12	EAST	148	2000	84.1	200	56.3	200
	CENTER	98.3	200	68.5	200	[illegible]	200
	WEST	70.7	200	46.5	200	[illegible]	[illegible]
8	EAST	296	2000	75.6	200	46.1	200
	CENTER	68.4	200	48.2	200	16.3	200
	WEST	56.2	200	41.8	200	12.[illegible]	200
4	EAST	186.5	200	46.4	200	[illegible]	[illegible]
	CENTER	79	200	36.2	200	[illegible]	200
	WEST	46.6	200	33.2	200	[illegible]	[illegible]

GELATIN STUDIES LARGE TANK 23 JUL 85
SMALL ROD
TRIAL RUN 7 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	321	2000	252	2000	231	2000
	CENTER	292	2000	143.7	200	129.2	200
	WEST	236	2000	126	200	101.9	200
12	EAST	197	2000	115.6	200	95.3	200
	CENTER	177	2000	88.5	200	69.2	200
	WEST	114	2000	85.5	200	63.6	200
8	EAST	156.2	200	81.4	200	56.3	200
	CENTER	157	2000	76	200	58.8	200
	WEST	147.3	200	78	200	53.4	200
4	EAST	114.4	200	59.2	200	44.3	200
	CENTER	176.7	200	79.3	200	51.8	200
	WEST	230	2000	68.3	200	44.3	200

LARGE ROD
TRIAL RUN 8 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	129	2000	83	2000	637	2000
	CENTER	22	2000	106.3	200	401	2000
	WEST	36	2000	76.9	200	87.2	200
12	EAST	32	2000	68.8	200	47.9	200
	CENTER	133.7	200	63.9	200	62.2	200
	WEST	88.2	200	56.9	200	51.[illegible]	200
8	EAST	124.4	200	56	200	51.6	200
	CENTER	113.4	200	61.9	200	54.3	200
	WEST	107	200	52.4	200	62.4	200
4	EAST	136.9	200	54.6	200	[illegible]	200
	CENTER	109	200	52.2	200	[illegible]	200
	WEST	64.4	200	37.9	200	37	200

GELATIN STUDIES LARGE TANK 26 JUL 85
SMALL ROD
TRIAL RUN 9 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	771	200	557	200	472	200
	CENTER	714	200	532	200	577	200
	WEST	779	200	753	200	471	200
12	EAST	570	200	474	200	683	200
	CENTER	647	200	504	200	370	200
	WEST	1355	200	178.7	200	143.4	200
8	EAST	613	200	317	200	305	200
	CENTER	595	200	174.6	200	134.8	200
	WEST	60.2	200	168.9	200	120	200
4	EAST	176.3	200	101.3	200	83.8	200
	CENTER	334	200	106	200	73.9	200
	WEST	317	200	106.9	200	90.3	200

LARGE ROD
TRIAL RUN 10 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	472	2000	178	2000	769	2000
	CENTER	88	2000	182	2000	376	2000
	WEST	96	2000	64	2000	98.8	200
12	EAST	145	2000	89.2	200	76.5	200
	CENTER	120	2000	69.2	200	77.6	200
	WEST	154.9	200	72.8	200	71.9	200
8	EAST	158.3	200	104	200	100.1	200
	CENTER	138.6	200	68	200	71.6	200
	WEST	107.4	200	61.5	200	63.3	200
4	EAST	104.9	200	51	200	49.4	200
	CENTER	83.7	200	41.5	200	38.1	200
	WEST	107.8	200	44.5	200	47.[illegible]	200

LEACHATE STUDIES LARGE TANK 30 JUL 85
SMALL ROD
TRIAL RUN 11 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	928	2000	643	2000	675	2000
	CENTER	703	2000	470	2000	447	2000
	WEST	474	2000	327	2000	196	200
12	EAST	465	2000	186.9	200	168.3	200
	CENTER	342	2000	153.9	200	148.1	200
	WEST	388	2000	152.8	200	137.2	200
8	EAST	330	2000	133.5	200	137.5	200
	CENTER	404	2000	164.2	200	135.3	200
	WEST	324	2000	130.7	200	129.8	200
4	EAST	383	2000	143.4	200	113.8	200
	CENTER	392	2000	150.1	200	116	200
	WEST	413	2000	133.9	200	112.4	200

LARGE ROD
TRIAL RUN 12 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	381	2000	399	2000	984	2000
	CENTER	456	2000	326	2000	510	2000
	WEST	329	2000	186.4	200	126.9	200
12	EAST	245	2000	104	200	93.5	200
	CENTER	198.3	200	97.1	200	86.9	200
	WEST	317	2000	91.7	200	80.4	200
8	EAST	288	2000	95.7	200	81.4	200
	CENTER	444	2000	102.4	200	102.3	200
	WEST	352	2000	90.3	200	96.1	200
4	EAST	174.2	200	81.8	200	61.3	200
	CENTER	163.7	200	82.5	200	74	200
	WEST	148.6	200	67.1	200	[illegible]	200

LEACHATE STUDIES LARGE TANK 30 JUL 85
SMALL TANK
TRIAL RUN 13 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	316	2000	148.9	200	118.4	200
	CENTER	616	2000	165.8	200	120.3	200
	WEST	359	2000	132.9	200	111	200
12	EAST	402	2000	115.2	200	98.4	200
	CENTER	359	2000	133.8	200	109.8	200
	WEST	456	2000	132.1	200	113.6	200
8	EAST	302	2000	111.5	200	100.1	200
	CENTER	340	2000	139.3	200	118.9	200
	WEST	388	2000	122.8	200	105.6	200
4	EAST	427	2000	138.5	200	101.5	200
	CENTER	276	2000	124.6	200	99.8	200
	WEST	302	2000	110	200	97.5	200

LARGE ROD
TRIAL RUN 14 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	634	2000	148.4	200	142.6	200
	CENTER	512	2000	93.3	200	114.1	200
	WEST	161.6	200	83.3	200	81.7	200
12	EAST	147.5	200	69.1	200	55.9	200
	CENTER	171.8	200	78.3	200	60.9	200
	WEST	150.9	200	71.8	200	59.1	200
8	EAST	141.6	200	75.1	200	65.8	200
	CENTER	190.4	200	81.7	200	86.3	200
	WEST	134.7	200	71.8	200	66.6	200
4	EAST	184.4	200	77.1	200	52	200
	CENTER	116.7	200	69.3	200	60.6	200
	WEST	71.4	200	47.4	200	49.8	200

RESISTOR DATA COMPARISON FOR LEACHATE BLOCK
31 JUL 85
SMALL ROD 10 M OHM RESISTOR
TRIAL RUN 15

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	99.2	200	61.7	200	55.4	200
	CENTER	96.7	200	59.3	200	54.9	200
	WEST	92.8	200	57.6	200	51.7	200
12	EAST	212	2000	87.2	200	65.4	200
	CENTER	94.7	200	64.9	200	57.9	200
	WEST	79.9	200	60.2	200	56.3	200
8	EAST	94.8	200	68.6	200	62.8	200
	CENTER	78.8	200	62.5	200	55.8	200
	WEST	73.5	200	62.5	200	56.4	200
4	EAST	86.8	200	64	200	54.2	200
	CENTER	73.9	200	59.7	200	54.8	200
	WEST	71.7	200	52.6	200	49.2	200

SMALL ROD 100 OHM RESISTOR
TRIAL RUN 16

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	78	200	47.5	200	42.1	200
	CENTER	51.9	200	38.2	200	39.5	200
	WEST	43.9	200	36.7	200	34	200
12	EAST	51.5	200	38.8	200	36.5	200
	CENTER	45.7	200	37.9	200	33.4	200
	WEST	39.4	200	33.6	200	31.7	200
8	EAST	53.6	200	40.4	200	35.8	200
	CENTER	41	200	34.2	200	32.5	200
	WEST	43.5	200	35.3	200	33.8	200
4	EAST	49.1	200	38.9	200	34.4	200
	CENTER	43.2	200	35.5	200	31.6	200
	WEST	39.8	200	30.9	200	[illegible]	200

RESISTOR DATA COMPARISON FOR LEACHATE BLOCK
31 JULY 85

SMALL ROD
TRIAL RUN 17 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
4	EAST	114.3	200	61.8	200	54.3	200
	CENTER	68.7	200	53.5	200	47.2	200
	WEST	64.6	200	50.9	200	42.3	200
4	EAST	49.1	200	38.9	200	34.4	200
	CENTER	43.2	200	35.5	200	31.6	200
	WEST	39.8	200	30.9	200	30.6	200
4	EAST	8.86	20	8.43	20	8.33	20
	CENTER	8.61	20	8.29	20	8.06	20
	WEST	8.5	20	8.2	20	8.1	20
4	EAST	0.99	2	0.99	2	0.987	2
	CENTER	0.991	2	0.985	2	0.982	2
	WEST	0.988	2	0.984	2	0.961	2
4	EAST	1.2	200 mV	1.2	200 mV	1.2	200 mV
	CENTER	1.2	200 mV	1.3	200 mV	1.2	200 mV
	WEST	1.3	200 mV	1.2	200 mV	1.3	200 mV

CHECK OF RESISTOR EFFECT ON METER READINGS
USING THE BREADBOARD
1 AUG 85

BOARD RESISTOR	TEST RESISTOR	METER READING: READING	METER READING: SCALE
		0.09	20 M
		98	2000
10.18 M	99.6	98.6	200
		OS	20
		OS	2
		0	20 M
		9	2000
10.18 M	9.89	9.8	200
		9.86	20
		OS	2
		0	20 M
		0	2000
10.18 M	1.005	0.9	200
		0.99	20
		1.008	2

BOARD RESISTOR	TEST RESISTOR	METER READING: READING	METER READING: SCALE
		0.09	20 M
		98	2000
99.9	10.18 M	98.6	200
		OS	20
		OS	2
		0	20 M
		8	2000
99.6	9.89	8.9	200
		8.99	20
		OS	2
		0	20 M
		0	2000
99.6	1.005	0.9	200
		0.98	20
		0.976	2

5 AUG 85
RUN 1

DIST (FT)		DEPTH 1/3 READING	SCALE	DEPTH 1/2 READING	SCALE	DEPTH 2/3 READING	SCALE
16	EAST	792	2000	346	2000	322	2000
	CENTER	373	2000	275	2000	176.3	200
	WEST	344	2000	153.8	200	141.3	200
12	EAST	251	2000	130.4	200	102.9	200
	CENTER	149.4	200	104.4	200	95.3	200
	WEST	151.5	200	105.8	200	91.3	200
8	EAST	164.6	200	110.8	200	92.9	200
	CENTER	130.1	200	92.3	200	79.8	200
	WEST	101.6	200	83.1	200	75.6	200
4	EAST	134.2	200	98.1	200	84.7	200
	CENTER	102.9	200	77.7	200	75.2	200
	WEST	108.7	200	81.5	200	76.4	200

5 AUG 85
RUN 2

DIST (FT)		DEPTH 1/3 READING	SCALE	DEPTH 1/2 READING	SCALE	DEPTH 2/3 READING	SCALE
16	EAST	188.2	200	140.1	200	106.2	200
	CENTER	193.3	200	123.6	200	103.9	200
	WEST	172.7	200	106.6	200	92	200
12	EAST	135	2000	100.6	200	79.9	200
	CENTER	135.4	200	92.3	200	79.4	200
	WEST	137	200	78.3	200	76.7	200
8	EAST	158.5	200	77.5	200	63	200
	CENTER	109.6	200	82.2	200	68.9	200
	WEST	99.6	200	85	200	67.1	200
4	EAST	129.1	200	82.9	200	74.5	200
	CENTER	113.3	200	85.5	200	70	200
	WEST	105.7	200	72.5	200	66.1	200

5 AUG 85
RUN 3

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	163.4	200	106.6	200	85.1	200
	CENTER	164.9	200	88.4	200	80.5	200
	WEST	162	200	84.3	200	84.9	200
12	EAST	313	200	77	200	64	200
	CENTER	100.3	200	72.9	200	58.3	200
	WEST	97.8	200	67.4	200	62.9	200
8	EAST	160.6	200	83.3	200	63.1	200
	CENTER	93.6	200	63	200	56.5	200
	WEST	87.8	200	76.6	200	60.8	200
4	EAST	149.8	200	85.6	200	72.1	200
	CENTER	89.6	200	63.7	200	59.7	200
	WEST	88.7	200	66.7	200	60.8	200

5 AUG 85
RUN 4

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	134.2	200	84.6	200	76.8	200
	CENTER	114.4	200	75.7	200	64.5	200
	WEST	125.9	200	75.2	200	66.7	200
12	EAST	110.9	200	71	200	61.2	200
	CENTER	96.9	200	70.8	200	60.3	200
	WEST	94.7	200	67.9	200	63.5	200
8	EAST	152.4	200	73.2	200	65.5	200
	CENTER	96.6	200	68.1	200	62.7	200
	WEST	88.3	200	75.9	200	65.1	200
4	EAST	105.9	200	74.9	200	69.9	200
	CENTER	75.2	200	60.8	200	55	200
	WEST	90.9	200	68.3	200	59.4	200

5 AUG 85
RUN 5

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	166.5	200	101.4	200	87.5	200
	CENTER	129	200	82.3	200	75.2	200
	WEST	138.2	200	93.8	200	77.2	200
12	EAST	133.1	200	78.2	200	65.7	200
	CENTER	93.4	200	71.1	200	61.8	200
	WEST	99.6	200	71.6	200	61.6	200
8	EAST	100.9	200	64.3	200	57	200
	CENTER	90.6	200	70.5	200	59.1	200
	WEST	100.4	200	71.3	200	60.6	200
4	EAST	101.9	200	66	200	59.8	200
	CENTER	83.2	200	65.3	200	57.1	200
	WEST	95.8	200	68.9	200	60.3	200

6 AUG 85
RUN 6

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1868	2000	442	2000	324	2000
	CENTER	613	2000	561	2000	459	2000
	WEST	597	2000	388	2000	316	2000
12	EAST	290	2000	186.7	200	129.4	200
	CENTER	342	2000	130.6	200	110	200
	WEST	137.4	200	110.2	200	70	200
8	EAST	369	2000	115.9	200	93.3	200
	CENTER	118.7	200	103.3	200	82.7	200
	WEST	121.7	200	83.7	200	70.1	200
4	EAST	113.5	200	82.5	200	73.9	200
	CENTER	111.1	200	79.3	200	65.8	200
	WEST	88.5	200	69.8	200	60.5	200

6 AUG 85
RUN 7

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	162.9	200	105.7	200	89.5	200
	CENTER	383	2000	106.6	200	88.9	200
	WEST	159	200	109.3	200	91.4	200
12	EAST	250	2000	92.5	200	72.7	200
	CENTER	98.4	200	62.7	200	56.9	200
	WEST	93.1	200	65.2	200	61.7	200
8	EAST	136.9	200	75.4	200	59	200
	CENTER	77.3	200	60.6	200	54.7	200
	WEST	71.7	200	47.8	200	48.1	200
4	EAST	126.6	200	60.6	200	46.3	200
	CENTER	76.4	200	46.5	200	40.3	200
	WEST	59.7	200	47	200	44.7	200

6 AUG 85
RUN 8

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	142.5	200	73.8	200	68	200
	CENTER	126.3	200	81.7	200	70	200
	WEST	124.5	200	87.9	200	78.1	200
12	EAST	105.5	200	81.7	200	86.9	200
	CENTER	81.5	200	64.2	200	59	200
	WEST	119.7	200	69.4	200	61.6	200
8	EAST	80.1	200	62.2	200	53.5	200
	CENTER	138.4	200	80.5	200	64.6	200
	WEST	88.4	200	54.1	200	49.2	200
4	EAST	151.2	200	73	200	62.7	200
	CENTER	79.3	200	57.6	200	50.1	200
	WEST	70.1	200	48.9	200	[illegible]	200

6 AUG 85
RUN 9

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	162.4	200	76	200	67.6	200
	CENTER	100.6	200	76.2	200	67.6	200
	WEST	126.8	200	86.6	200	66.5	200
12	EAST	219	2000	79.4	200	61.1	200
	CENTER	88.4	200	66.8	200	53.3	200
	WEST	87.3	200	58.1	200	54.3	200
8	EAST	170.1	200	62.9	200	58.6	200
	CENTER	79.2	200	54.6	200	51.6	200
	WEST	73.8	200	54.1	200	52.7	200
4	EAST	113	200	70.6	200	58.5	200
	CENTER	68.9	200	47.4	200	44	200
	WEST	71.4	200	52.6	200	46.7	200

5 AUG 85
RUN 10

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	121.9	200	83.1	200	76.6	200
	CENTER	134.8	200	71.9	200	64.9	200
	WEST	99.7	200	73.5	200	64.4	200
12	EAST	118.3	200.	66	200	55	200
	CENTER	68.7	200	56.5	200	49.9	200
	WEST	104.6	200	53.5	200	45.1	200
8	EAST	114.7	200	58.5	200	51.7	200
	CENTER	63.8	200	49.6	200	46.7	200
	WEST	59	200	52.5	200	48.6	200
4	EAST	74.5	200	46.6	200	41.8	200
	CENTER	62.1	200	43	200	41.2	200
	WEST	39.9	200	41	200	39.7	200

6 AUG 85
RUN 11

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	425	2000	93.6	200	71.2	200
	CENTER	90.7	200	61	200	57.2	200
	WEST	82.1	200	63.4	200	56.9	200
12	EAST	122.9	200	55.2	200	52.3	200
	CENTER	71.8	200	52.4	200	47.9	200
	WEST	100.1	200	75.9	200	64.3	200
8	EAST	151.7	200	53.7	200	41	200
	CENTER	85.9	200	60.2	200	53.[illegible]	200
	WEST	64.3	200	52.7	200	49.8	200
[illegible]	EAST	105.1	200	51.4	200	46	200
	CENTER	64.5	200	48.3	200	44	200
	WEST	75.6	200	55	200	47.1	200

6 AUG 85
RUN 12

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	177.9	200	64.2	200	55.7	[illegible]
	CENTER	76.8	200	62.3	200	67.[illegible]	[illegible]
	WEST	91.9	200	69.1	200	55.7	200
[illegible]	EAST	97.6	200	52.1	200	[illegible]	[illegible]
	CENTER	65.7	200	51.5	200	[illegible]	[illegible]
	WEST	66.2	200	57.8	200	[illegible]	[illegible]
[illegible]	EAST	602	2000	110.8	200	[illegible]	[illegible]
	CENTER	124.4	200	85.7	200	[illegible]	[illegible]
	WEST	95.3	200	77.1	200	67.4	[illegible]
[illegible]	EAST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6 AUG 85
RUN 13

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	196.3	200	75.3	200	64.7	200
	CENTER	116.4	200	74.8	200	62.4	200
	WEST	91.5	200	71.6	200	65.2	200
12	EAST	123.9	200	51.4	200	50	200
	CENTER	65.8	200	51.5	200	49.7	200
	WEST	80.7	200	54.8	200	49.4	200
8	EAST	71.3	200	54.3	200	47	200
	CENTER	58.5	200	53.7	200	49.2	200
	WEST	66.9	200	52.5	200	47.5	200
4	EAST	81.4	200	57.3	200	48.4	200
	CENTER	61.2	200	51.1	200	46.1	200
	WEST	59.1	200	48.8	200	41	200

7 AUG 85
RUN 14

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	720	2000	417	2000	446	2000
	CENTER	598	2000	367	2000	333	2000
	WEST	578	2000	292	2000	158.3	200
12	EAST	408	2000	164.7	200	128.9	200
	CENTER	189	200	127	200	116.2	200
	WEST	145.9	200	104.8	200	92.5	200
8	EAST	190.5	200	112.5	200	93.2	200
	CENTER	115.5	200	91.4	200	81.1	200
	WEST	110.6	200	87	200	78.9	200
4	EAST	398	2000	101.3	200	88.2	200
	CENTER	97.8	200	78.7	200	71.7	200
	WEST	93.7	200	70.2	200	63.3	200

7 AUG 85
RUN 15

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	425.0	2000	177.9	200	540.0	2000
	CENTER	545.0	2000	558.0	2000	130.8	200
	WEST	466.0	2000	138.7	200	129.9	200
12	EAST	476.0	2000	122.2	200	100.0	200
	CENTER	133.4	200	94.3	200	84.2	200
	WEST	114.1	200	80.6	200	79.4	200
8	EAST	262.0	2000	96.8	200	91.1	200
	CENTER	111.8	200	75.7	200	69.7	200
	WEST	92.0	200	61.9	200	63.7	200
4	EAST	144.7	200	86.3	200	66.1	200
	CENTER	98.0	200	62.2	200	62.4	200
	WEST	82.8	200	59.3	200	53.9	200

7 AUG 85
RUN 16

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	922.0	2000	567.0	2000	1056.0	2000
	CENTER	534.0	2000	423.0	2000	295.0	2000
	WEST	395.0	2000	398.0	2000	313.0	2000
12	EAST	456.0	2000	317.0	2000	391.0	2000
	CENTER	226.0	2000	126.2	200	114.9	200
	WEST	193.1	200	102.7	200	93.9	200
8	EAST	171.9	200	132.4	200	99.9	200
	CENTER	111.0	200	95.9	200	81.5	200
	WEST	106.7	200	83.9	200	75.2	200
4	EAST	158.6	200	79.6	200	65.9	200
	CENTER	91.8	200	62.7	200	54.6	200
	WEST	85.0	200	53.6	200	54.7	[illegible]

7 AUG 85
RUN 17

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1384	2000	487	2000	597	2000
	CENTER	608	2000	394	2000	383	2000
	WEST	562	2000	195.7	2000	278	2000
12	EAST	620	2000	251	2000	152.6	200
	CENTER	421	2000	139	200	140.9	200
	WEST	301	2000	123.2	200	91.6	200
8	EAST	339	2000	143.5	200	103.8	200
	CENTER	144.9	200	100.3	200	74.7	200
	WEST	133.9	200	79.1	200	79.4	200
4	EAST	496	2000	84.5	200	66.6	200
	CENTER	162.8	200	81.3	200	59.8	200
	WEST	147.7	200	75.8	200	59.2	200

7 AUG 85
RUN 18

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	667	2000	152	2000	131	2000
	CENTER	255	2000	177	200	130.5	200
	WEST	279	2000	173.1	200	121.2	200
12	EAST	271	2000	157.4	200	162.5	200
	CENTER	151	2000	96	200	110.5	200
	WEST	157.8	200	97.2	200	74.3	200
8	EAST	242	2000	95.4	200	80.4	200
	CENTER	109.7	200	75.7	200	66.5	200
	WEST	89.1	200	63.9	200	59.2	200
4	EAST	152.4	200	68.2	200	[illegible]	200
	CENTER	101.1	200	58.5	200	[illegible]	200
	WEST	74.1	200	57.9	200	[illegible]	200

8 AUG 85
RUN 19

DIST		DEPTH 1/3		1/2		2/3	
(FT)		READING	SCALE	READING	SCALE	READING	SCALE
16	EAST	345	2000	288	2000	5.82	20M
	CENTER	385	2000	310	2000	255	2000
	WEST	628	2000	362	2000	284	2000
12	EAST	406	2000	292	2000	256	2000
	CENTER	363	2000	174.7	200	132.9	200
	WEST	169.9	200	139.9	200	122.1	200
8	EAST	159.1	200	102	200	92.3	200
	CENTER	118.5	200	103.6	200	93.4	200
	WEST	106.9	200	100.1	200	85.3	200
4	EAST	162.8	200	99.2	200	77	200
	CENTER	126.7	200	81	200	67.8	200
	WEST	90.7	200	65.5	200	57.2	200

8 AUG 85
RUN 20

DIST		DEPTH 1/3		1/2		2/3	
(FT)		READING	SCALE	READING	SCALE	READING	SCALE
16	EAST	7.46	20M	383	2000	74.8	200
	CENTER	558	2000	151	200	69.5	200
	WEST	403	2000	157	200	51.4	200
12	EAST	80	2000	79.5	200	34.5	200
	CENTER	847	2000	814	2000	802	2000
	WEST	182.3	200	44.5	200	24.2	200
8	EAST	138.8	200	63.2	200	32.3	200
	CENTER	142.2	200	28.6	200	20.3	200
	WEST	80.5	200	35.2	200	24.6	200
4	EAST	182.9	200	60.9	200	25.8	200
	CENTER	63.9	200	36.3	200	19	200
	WEST	52.3	200	30.2	200	26.1	200

8 AUG 85
RUN 21

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	449	2000	253	2000	1158	2000
	CENTER	573	2000	939	2000	216	2000
	WEST	117.5	2000	329	2000	645	2000
12	EAST	515	2000	220	2000	226	2000
	CENTER	579	2000	203	2000	166.8	200
	WEST	225	2000	159.2	200	160.6	200
8	EAST	222	2000	149	200	121.2	200
	CENTER	150.9	200	167.9	200	121.9	200
	WEST	142.2	200	104.7	200	117.9	200
4	EAST	390	2000	112.8	200	89.1	200
	CENTER	113.7	200	106.8	200	83.3	200
	WEST	117.9	200	83.6	200	70.6	200

8 AUG 85
RUN 22

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	8.56	20 M	8.96	20 M	8.99	20 M
	CENTER	379	2000	390	2000	265	2000
	WEST	456	2000	343	2000	702	2000
12	EAST	376	2000	369	2000	857	2000
	CENTER	356	2000	547	2000	491	2000
	WEST	450	2000	546	2000	549	2000
8	EAST	418	2000	470	2000	627	2000
	CENTER	1725	2000	448	2000	539	2000
	WEST	158.7	200	155.4	200	145.5	200
4	EAST	808	2000	175.8	200	150	200
	CENTER	166.7	200	121.8	200	121.3	200
	WEST	140.5	200	107.7	200	96.1	200

8 AUG 85
RUN 23

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	801	2000	346	2000	442	2000
	CENTER	547	2000	326	2000	347	2000
	WEST	533	2000	242	2000	383	2000
12	EAST	644	2000	329	2000	250	2000
	CENTER	474	2000	330	2000	186.4	200
	WEST	292	2000	167.8	200	151.3	200
8	EAST	482	2000	162.6	200	150.9	200
	CENTER	163.1	200	120.5	200	105.6	200
	WEST	140.1	200	123.7	200	110.7	200
4	EAST	319	2000	112.2	200	101.4	200
	CENTER	103.8	200	78.3	200	70.9	200
	WEST	107.6	200	68.9	200	68	200

8 AUG 85
RUN 24

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1429	2000	401	2000	142	200
	CENTER	799	2000	158.9	200	139.7	200
	WEST	622	2000	153.8	200	145	200
12	EAST	2.44	20 M	2.94	20 M	0.45	200
	CENTER	391	2000	105.8	200	141.6	200
	WEST	199.3	200	115.7	200	59.7	200
8	EAST	349	2000	137.9	200	76.4	200
	CENTER	149.5	200	69.7	200	61.3	200
	WEST	109.9	200	61.5	200	56.9	200
4	EAST	223	2000	74.1	200	10.8	200
	CENTER	74	200	35.6	200	41.3	200
	WEST	68.5	200	29.4	200	21.[illegible]	200

9 AUG 85
RUN 25

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1.13	20 M	639	2000	552	2000
	CENTER	946	2000	533	2000	1053	2000
	WEST	769	2000	535	2000	458	2000
12	EAST	567	2000	359	2000	358	2000
	CENTER	406	2000	331	2000	301	2000
	WEST	307	2000	169	200	172.9	200
8	EAST	411	2000	191.9	200	166.1	200
	CENTER	197.7	200	152.7	200	120.3	200
	WEST	168.9	200	124.9	200	107.9	200
4	EAST	277	2000	129	200	NO DATA	200
	CENTER	172.9	200	110	200	97.2	200
	WEST	135.9	200	85.9	200	76.7	200

9 AUG 85
RUN 26

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	395	2000	356	2000	330	2000
	CENTER	383	2000	375	2000	394	2000
	WEST	478	2000	361	2000	414	2000
12	EAST	483	2000	234	2000	368	2000
	CENTER	307	2000	199	2000	191.1	200
	WEST	250	2000	162.4	200	168.7	200
8	EAST	1225	2000	502	2000	184.1	200
	CENTER	398	2000	338	2000	391	2000
	WEST	161.7	200	134.3	200	118.9	200
4	EAST	340	2000	146.4	200	117.9	200
	CENTER	146	200	77.8	200	59.9	200
	WEST	93	200	69.4	200	56.2	200

9 AUG 85
RUN 27

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	438	2000	408	2000	312	2000
	CENTER	977	2000	961	2000	308	2000
	WEST	424	2000	354	2000	803	2000
12	EAST	464	2000	344	2000	536	2000
	CENTER	367	2000	298	2000	261	2000
	WEST	327	2000	282	2000	421	2000
8	EAST	401	2000	348	2000	375	2000
	CENTER	390	2000	188	200	174.3	200
	WEST	376	2000	340	2000	342	2000
4	EAST	264	2000	249	2000	168.7	200
	CENTER	174.9	2000	138.9	200	129.2	200
	WEST	152.5	200	131.2	200	106.3	200

9 AUG 85
RUN 28

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	656	2000	524	2000	604	2000
	CENTER	671	2000	346	2000	393	2000
	WEST	576	2000	476	2000	529	2000
12	EAST	617	2000	518	2000	284	2000
	CENTER	559	2000	457	2000	199.9	200
	WEST	434	2000	281	2000	244	2000
8	EAST	777	2000	247	2000	81	2000
	CENTER	445	2000	174.4	200	188.5	200
	WEST	290	2000	181.6	200	154.1	200
4	EAST	604	2000	375	2000	391	2000
	CENTER	253	2000	160.2	200	[illegible]	200
	WEST	192	200	115.8	200	[illegible]	[illegible]

9 AUG 85
RUN 29

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	897	2000	340	2000	297	2000
	CENTER	607	2000	394	2000	318	2000
	WEST	665	2000	365	2000	310	2000
12	EAST	599	2000	418	2000	276	2000
	CENTER	404	2000	381	2000	292	2000
	WEST	380	2000	187.8	200	179.2	200
8	EAST	617	2000	344	2000	198.6	200
	CENTER	435	2000	183.9	200	153.3	200
	WEST	376	2000	166.7	200	125.2	200
4	EAST	364	2000	178.7	200	129.2	200
	CENTER	295	2000	139.1	200	107.4	200
	WEST	186	200	108.3	200	87.2	200

9 AUG 85
RUN 30

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	535	2000	312	2000	530	2000
	CENTER	653	2000	381	2000	300	2000
	WEST	475	2000	354	2000	275	2000
12	EAST	656	2000	421	2000	474	2000
	CENTER	403	2000	409	2000	275	2000
	WEST	329	2000	226	2000	224	2000
8	EAST	666	2000	312	2000	445	2000
	CENTER	320	2000	223	2000	186.8	200
	WEST	327	2000	247	2000	350	2000
4	EAST	319	2000	203	2000	192.9	200
	CENTER	261	2000	158.8	200	160.5	200
	WEST	190.1	200	140.8	200	171.5	200

12 AUG 85
RUN 1

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	550	2000	611	2000	804	2000
	CENTER	511	2000	420	2000	420	2000
	WEST	714	2000	431	2000	618	2000
12	EAST	529	2000	336	2000	411	2000
	CENTER	365	2000	276	2000	240	2000
	WEST	309	2000	276	2000	242	2000
8	EAST	435	2000	273	2000	198	200
	CENTER	330	2000	269	2000	187.3	200
	WEST	277	2000	183.4	200	170.7	200
4	EAST	261	2000	180	200	167.5	200
	CENTER	278	2000	162.3	200	161.7	200
	WEST	193	200	144.9	200	145	200

12 AUG 85
RUN 2

DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	541	2000	345	2000	355	2000
	CENTER	469	2000	299	2000	170	200
	WEST	636	2000	280	2000	194.4	200
12	EAST	319	2000	180	200	151.1	200
	CENTER	322	2000	152.9	200	132.3	200
	WEST	182.1	200	150.3	200	131.5	200
8	EAST	309	2000	169.2	200	120	200
	CENTER	180	200	131	200	116.4	200
	WEST	138.4	200	122.8	200	107.5	200
4	EAST	198.3	200	127.1	200	104.5	200
	CENTER	176.7	200	101.3	200	95.1	200
	WEST	143.2	200	99	200	82.8	200

12 AUG 85
RUN 3

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	373	2000	171	2000	124.3	200
	CENTER	242	2000	132.1	200	112.4	200
	WEST	331	2000	141.2	200	119	200
12	EAST	353	2000	120.6	200	90.6	200
	CENTER	163	200	103.2	200	82.6	200
	WEST	130.9	200	91.1	200	79.2	200
8	EAST	192	2000	105.6	200	79.4	200
	CENTER	124	200	81.6	200	75.4	200
	WEST	108.9	200	79.2	200	76.6	200
4	EAST	127	2000	91.2	200	68.4	200
	CENTER	95.3	200	68.1	200	66.3	200
	WEST	95.3	200	69.1	200	66	200

12 AUG 85
RUN 4

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	4.64	20 M	899	2000	565	2000
	CENTER	1.23	20 M	533	2000	336	2000
	WEST	579	2000	616	2000	343	2000
12	EAST	1344	2000	395	2000	705	2000
	CENTER	774	2000	385	2000	366	2000
	WEST	478	2000	341	2000	193	200
8	EAST	745	2000	514	2000	357	2000
	CENTER	448	2000	170.2	200	145.8	200
	WEST	194.6	200	155.6	200	132.9	200
4	EAST	421	2000	150.7	200	113.4	200
	CENTER	178.6	200	132.7	200	99	200
	WEST	127.7	200	99.5	200	87.1	200

12 AUG 85
RUN 5

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	718	2000	335	2000	345	2000
	CENTER	557	2000	164.7	200	138.3	200
	WEST	295	2000	159.2	200	138.5	200
12	EAST	368	2000	138	200	118.5	200
	CENTER	181.4	200	119.8	200	94.8	200
	WEST	143	200	111.7	200	99.9	200
8	EAST	569	2000	163.7	200	125.5	200
	CENTER	171	200	102.1	200	89.5	200
	WEST	121	200	103.2	200	94.5	200
4	EAST	432	2000	118.1	200	92.1	200
	CENTER	127.9	200	90.4	200	80.6	200
	WEST	109.2	200	88	200	75.2	200

12 AUG 85
RUN 6

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1565	2000	419	2000	335	2000
	CENTER	523	2000	455	2000	281	2000
	WEST	483	2000	358	2000	357	2000
12	EAST	540	2000	280	2000	389	2000
	CENTER	302	2000	231	2000	181.8	200
	WEST	240	2000	150.6	200	157	200
8	EAST	579	2000	278	2000	174.9	200
	CENTER	335	2000	155.3	200	129.1	200
	WEST	179.4	200	112.6	200	114.8	200
4	EAST	310	2000	167.5	200	135.8	200
	CENTER	151	200	97.7	200	91	200
	WEST	124.6	200	79.7	200	77.6	200

13 AUG 85
RUN 7

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	4.08	20 M	1021	2000	735	2000
	CENTER	822	2000	599	2000	579	2000
	WEST	583	2000	637	2000	541	2000
12	EAST	675	2000	434	2000	410	2000
	CENTER	433	2000	524	2000	590	2000
	WEST	398	2000	442	2000	432	2000
8	EAST	433	2000	400	2000	409	2000
	CENTER	265	2000	402	2000	194.4	200
	WEST	252	2000	373	2000	167.5	200
4	EAST	340	2000	281	2000	179.6	200
	CENTER	274	2000	162.8	200	145.3	200
	WEST	265	2000	160.6	200	156	200

13 AUG 85
RUN 8

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	3.48	20 M	867	2000	547	2000
	CENTER	782	2000	404	2000	251	2000
	WEST	592	2000	486	2000	201	2000
12	EAST	788	2000	223	2000	254	2000
	CENTER	503	2000	127	2000	166	2000
	WEST	435	2000	320	2000	314	2000
8	EAST	544	2000	227	2000	267	2000
	CENTER	251	2000	285	2000	181.5	200
	WEST	336	2000	166.2	200	146.1	200
4	EAST	345	2000	284	2000	[illegible]	2000
	CENTER	154	2000	156.3	200	126.9	200
	WEST	172.9	200	122.3	200	117.1	200

13 AUG 85
RUN 9

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1302	2000	564	2000	804	2000
	CENTER	733	2000	574	2000	511	2000
	WEST	717	2000	654	2000	571	2000
12	EAST	613	2000	475	2000	514	2000
	CENTER	766	2000	609	2000	314	2000
	WEST	557	2000	460	2000	459	2000
8	EAST	516	2000	340	2000	336	2000
	CENTER	355	2000	184.3	200	176.4	200
	WEST	199.5	200	151	200	161.4	200
4	EAST	345	2000	192.3	200	185.9	200
	CENTER	308	2000	172.1	200	118.2	200
	WEST	194.9	200	144.9	200	117	200

13 AUG 85
RUN 10

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	808	2000	269	2000	157	2000
	CENTER	691	2000	292	2000	231	2000
	WEST	622	2000	216	2000	231	2000
12	EAST	599	2000	268	2000	277	2000
	CENTER	341	2000	178	200	165.4	200
	WEST	225	2000	171.2	200	174.5	200
8	EAST	505	2000	253	2000	174.6	200
	CENTER	253	2000	157.6	200	113.2	200
	WEST	169	200	111.9	200	114.9	200
4	EAST	236	2000	141.1	200	123.2	200
	CENTER	290	2000	129.1	200	84	200
	WEST	173	200	111.6	200	[illegible]	[illegible]

13 AUG 85
RUN 11

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1701	2000	601	2000	879	2000
	CENTER	800	2000	578	2000	297	2000
	WEST	824	2000	355	2000	273	2000
12	EAST	587	2000	254	2000	597	2000
	CENTER	624	2000	300	2000	231	2000
	WEST	483	2000	371	2000	282	2000
8	EAST	762	2000	440	2000	436	2000
	CENTER	393	2000	267	2000	267	2000
	WEST	368	2000	191.7	200	196	200
4	EAST	400	2000	241	2000	324	2000
	CENTER	266	2000	172.6	200	133.5	200
	WEST	299	2000	173.4	200	126.8	200

13 AUG 85
RUN 12

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1650	2000	684	2000	911	2000
	CENTER	660	2000	501	2000	417	2000
	WEST	676	2000	531	2000	524	2000
12	EAST	781	2000	366	2000	307	2000
	CENTER	744	2000	358	2000	326	2000
	WEST	438	2000	304	2000	334	2000
8	EAST	723	2000	386	2000	385	2000
	CENTER	656	2000	436	2000	176.3	200
	WEST	376	2000	164.7	200	163.7	200
4	EAST	326	2000	189.6	200	167	200
	CENTER	336	2000	136.4	200	113.5	200
	WEST	164.8	200	124	200	[illegible]	200

14 AUG 85
RUN 13

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1117	2000	577	2000	10.6	20 M
	CENTER	1025	2000	788	2000	571	2000
	WEST	674	2000	719	2000	478	2000
12	EAST	576	2000	373	2000	570	2000
	CENTER	552	2000	387	2000	301	2000
	WEST	426	2000	321	2000	280	2000
8	EAST	385	2000	278	2000	196.1	200
	CENTER	515	2000	266	2000	295	2000
	WEST	273	2000	181.8	200	159.9	200
4	EAST	359	2000	194.4	200	160.8	200
	CENTER	261	2000	177.9	200	174.8	200
	WEST	188.2	200	132	200	114.7	200

14 AUG 85
RUN 14

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	470	2000	387	2000	273	2000
	CENTER	523	2000	325	2000	186.8	200
	WEST	417	2000	279	2000	195	2000
12	EAST	626	2000	250	2000	155	200
	CENTER	250	2000	136.3	200	120.7	200
	WEST	245	2000	145.8	200	115.5	200
8	EAST	377	2000	161.4	200	128	200
	CENTER	179.9	200	105	200	88.7	200
	WEST	139.1	200	95.9	200	99.4	200
4	EAST	267	2000	117.8	200	106.7	200
	CENTER	127.3	200	94.3	200	84.3	200
	WEST	112.5	200	82.3	200	[illegible]	200

14 AUG 85
RUN 15

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	891	2000	645	2000	859	2000
	CENTER	814	2000	777	2000	693	2000
	WEST	759	2000	797	2000	700	2000
12	EAST	748	2000	539	2000	955	2000
	CENTER	611	2000	485	2000	447	2000
	WEST	530	2000	495	2000	426	2000
8	EAST	567	2000	450	2000	380	2000
	CENTER	620	2000	498	2000	530	2000
	WEST	417	2000	352	2000	495	2000
4	EAST	540	2000	397	2000	743	2000
	CENTER	635	2000	589	2000	285	2000
	WEST	454	2000	364	2000	324	2000

14 AUG 85
RUN 16

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1265	2000	1160	2000	1701	2000
	CENTER	950	2000	715	2000	538	2000
	WEST	727	2000	746	2000	637	2000
12	EAST	1091	2000	462	2000	1061	2000
	CENTER	551	2000	455	2000	379	2000
	WEST	478	2000	418	2000	363	2000
8	EAST	532	2000	315	2000	418	2000
	CENTER	295	2000	261	2000	193.5	200
	WEST	316	2000	282	2000	187	200
4	EAST	425	2000	258	2000	257	2000
	CENTER	285	2000	168.8	200	155.3	200
	WEST	178.5	200	141.6	200	131.6	[illegible]

14 AUG 85
RUN 17

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	877	2000	372	2000	447	2000
	CENTER	531	2000	493	2000	367	2000
	WEST	487	2000	399	2000	343	2000
12	EAST	864	2000	346	2000	421	2000
	CENTER	331	2000	242	2000	185.3	200
	WEST	352	2000	259	2000	164.4	200
8	EAST	548	2000	228	2000	190	200
	CENTER	286	2000	160.8	200	139.1	200
	WEST	175.9	200	135.9	200	153	200
4	EAST	365	2000	164.7	200	146.5	200
	CENTER	234	2000	137.2	200	114.8	200
	WEST	181.6	200	108	200	99.7	200

14 AUG 85
RUN 18

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1054	2000	542	2000	452	2000
	CENTER	1087	2000	1007	2000	507	2000
	WEST	920	2000	649	2000	527	2000
12	EAST	3.14	20 M	496	2000	470	2000
	CENTER	689	2000	1994	2000	436	2000
	WEST	566	2000	549	2000	368	2000
8	EAST	900	2000	439	2000	381	2000
	CENTER	627	2000	636	2000	344	2000
	WEST	319	2000	300	2000	316	2000
4	EAST	959	2000	367	2000	313	2000
	CENTER	321	2000	285	2000	262	2000
	WEST	236	2000	211	2000	190.5	200

15 AUG 85
RUN 19

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	598	2000	433	2000	391	2000
	CENTER	504	2000	459	2000	419	2000
	WEST	443	2000	389	2000	382	2000
12	EAST	442	2000	320	2000	175.8	200
	CENTER	245	2000	181.9	200	120	200
	WEST	307	2000	146	200	119.5	200
8	EAST	401	2000	178	200	116.8	200
	CENTER	265	2000	118.8	200	82.5	200
	WEST	275	2000	124.5	200	79	200
4	EAST	329	2000	128	200	69.7	200
	CENTER	351	2000	148.1	200	83.2	200
	WEST	187.9	200	102.9	200	75	200

15 AUG 85
RUN 20

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	772	2000	476	2000	366	2000
	CENTER	610	2000	481	2000	458	2000
	WEST	471	2000	622	2000	319	2000
12	EAST	560	2000	419	2000	433	2000
	CENTER	517	2000	341	2000	145.2	200
	WEST	387	2000	184.6	200	112.1	200
8	EAST	498	2000	173	200	123	200
	CENTER	422	2000	156.9	200	121.9	200
	WEST	392	2000	149.1	200	100.1	200
4	EAST	441	2000	174.3	200	159.2	200
	CENTER	342	2000	106.2	200	76.3	200
	WEST	309	2000	123	200	83.4	200

15 AUG 85
RUN 21

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	936	2000	530	2000	477	2000
	CENTER	650	2000	405	2000	335	2000
	WEST	476	2000	357	2000	228	2000
12	EAST	817	2000	354	2000	315	2000
	CENTER	368	2000	250	2000	186.8	200
	WEST	353	2000	149.9	200	396	2000
8	EAST	413	2000	279	2000	178.5	200
	CENTER	412	2000	164	200	131	200
	WEST	389	2000	151.3	200	136.7	200
4	EAST	417	2000	147.2	200	115.3	200
	CENTER	225	2000	109	200	94.1	200
	WEST	280	2000	154.1	200	101.3	200

15 AUG 85
RUN 22

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	926	2000	494	2000	349	2000
	CENTER	672	2000	421	2000	296	2000
	WEST	563	2000	312	2000	194.1	200
12	EAST	443	2000	316	2000	140.6	200
	CENTER	1250	2000	217	2000	116.9	200
	WEST	399	2000	134.8	200	97.9	200
8	EAST	421	2000	162.1	200	95.4	200
	CENTER	195.3	200	84.2	200	84.4	200
	WEST	176.9	200	92.8	200	81.8	200
4	EAST	538	2000	136.7	200	78.2	200
	CENTER	266	2000	72.6	200	62.2	200
	WEST	269	200	163.2	200	72.1	200

15 AUG 85
RUN 23

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	997	2000	768	2000	534	2000
	CENTER	899	2000	514	2000	406	2000
	WEST	754	2000	482	2000	358	2000
12	EAST	891	2000	508	2000	443	2000
	CENTER	819	2000	468	2000	305	2000
	WEST	404	2000	342	2000	245	2000
8	EAST	649	2000	384	2000	337	2000
	CENTER	352	2000	289	2000	181.4	200
	WEST	340	2000	262	2000	162.1	200
4	EAST	660	2000	415	2000	272	2000
	CENTER	385	2000	247	2000	154.3	200
	WEST	462	2000	312	2000	151.2	200

15 AUG 85
RUN 24

DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	3.07	20 M	946	2000	671	2000
	CENTER	1101	2000	626	2000	784	2000
	WEST	1216	2000	558	2000	410	2000
12	EAST	1096	2000	577	2000	482	2000
	CENTER	870	2000	426	2000	351	2000
	WEST	833	2000	317	2000	330	2000
8	EAST	591	2000	324	2000	189.6	200
	CENTER	496	2000	278	2000	162.5	200
	WEST	475	2000	325	2000	361	2000
4	EAST	774	2000	375	2000	322	2000
	CENTER	396	2000	186.3	200	150.2	200
	WEST	423	2000	371	2000	147.2	200

16 AUG 85
RUN 25

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	796	2000	635	2000	513	2000
	CENTER	897	2000	547	2000	492	2000
	WEST	732	2000	697	2000	438	2000
12	EAST	577	2000	343	2000	263	2000
	CENTER	578	2000	418	2000	324	2000
	WEST	465	2000	287	2000	214	2000
8	EAST	440	2000	330	2000	197.1	200
	CENTER	339	2000	311	2000	292	2000
	WEST	337	2000	332	2000	196.7	200
4	EAST	504	2000	274	2000	189.2	200
	CENTER	394	2000	325	2000	195.5	200
	WEST	323	2000	311	2000	182.2	200

16 AUG 85
RUN 26

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	749	2000	728	2000	549	2000
	CENTER	965	2000	830	2000	585	2000
	WEST	830	2000	882	2000	673	2000
12	EAST	663	2000	555	2000	1260	2000
	CENTER	1647	2000	642	2000	533	2000
	WEST	680	2000	733	2000	431	2000
8	EAST	614	2000	438	2000	364	2000
	CENTER	536	2000	422	2000	331	2000
	WEST	421	2000	338	2000	194.2	200
4	EAST	776	2000	454	2000	275	2000
	CENTER	491	2000	331	2000	183	200
	WEST	409	2000	298	2000	[illegible]	200

16 AUG 85
RUN 27

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	901	2000	737	2000	460	2000
	CENTER	1175	2000	732	2000	495	2000
	WEST	882	2000	857	2000	474	2000
12	EAST	948	2000	483	2000	344	2000
	CENTER	984	2000	541	2000	358	2000
	WEST	517	2000	426	2000	301	2000
8	EAST	674	2000	304	2000	242	2000
	CENTER	330	2000	292	2000	176.4	200
	WEST	397	2000	286	2000	168.1	200
4	EAST	513	2000	312	2000	151.7	200
	CENTER	386	2000	264	2000	152	200
	WEST	326	2000	177.4	200	136.9	200

16 AUG 85
RUN 28

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	916	2000	385	2000	231	2000
	CENTER	838	2000	424	2000	305	2000
	WEST	634	2000	469	2000	388	2000
12	EAST	551	2000	333	2000	275	2000
	CENTER	723	2000	443	2000	306	2000
	WEST	676	2000	437	2000	196.6	200
8	EAST	521	2000	290	2000	178.9	200
	CENTER	411	2000	179.7	200	149	200
	WEST	359	2000	185.5	200	155.7	200
4	EAST	782	2000	347	2000	169	200
	CENTER	410	2000	265	2000	150	200
	WEST	291	2000	164.2	200	141.7	200

16 AUG 85
RUN 29 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1030	2000	668	2000	552	2000
	CENTER	1157	2000	805	2000	512	2000
	WEST	1038	2000	1066	2000	758	2000
12	EAST	819	2000	458	2000	371	2000
	CENTER	1286	2000	614	2000	463	2000
	WEST	878	2000	599	2000	521	2000
8	EAST	1216	2000	463	2000	415	2000
	CENTER	606	2000	394	2000	369	2000
	WEST	576	2000	385	2000	368	2000
4	EAST	1145	2000	519	2000	362	2000
	CENTER	659	2000	407	2000	310	2000
	WEST	439	2000	316	2000	417	2000

16 AUG 85
RUN 30 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1137	2000	834	2000	549	2000
	CENTER	1339	2000	774	2000	507	2000
	WEST	1434	2000	860	2000	595	2000
12	EAST	881	2000	419	2000	379	2000
	CENTER	1338	2000	591	2000	381	2000
	WEST	817	2000	510	2000	249	2000
8	EAST	645	2000	306	2000	285	2000
	CENTER	396	2000	333	2000	271	2000
	WEST	327	2000	294	2000	247	2000
4	EAST	904	2000	307	2000	[illegible]	2000
	CENTER	492	2000	267	2000	127	2000
	WEST	309	2000	227	2000	126	[illegible]

19 AUG 85

RUN 1 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1581	2000	1218	2000	900	2000
	CENTER	1789	2000	1161	2000	746	2000
	WEST	4.03	20 M	1489	2000	804	2000
12	EAST	1049	2000	777	2000	515	2000
	CENTER	846	2000	598	2000	512	2000
	WEST	776	2000	573	2000	394	2000
8	EAST	380	2000	228	2000	230	2000
	CENTER	691	2000	370	2000	297	2000
	WEST	579	2000	426	2000	360	2000
4	EAST	814	2000	374	2000	182.6	200
	CENTER	704	2000	399	2000	269	2000
	WEST	833	2000	325	2000	265	2000

19 AUG 85

RUN 2 DEPTH

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	996	2000	464	2000	370	2000
	CENTER	1855	2000	738	2000	396	2000
	WEST	1814	2000	845	2000	550	2000
12	EAST	1181	2000	568	2000	344	2000
	CENTER	1228	2000	453	2000	349	2000
	WEST	767	2000	389	2000	268	2000
8	EAST	1045	2000	298	2000	192.6	200
	CENTER	905	2000	386	2000	270	2000
	WEST	559	2000	287	2000	165.8	200
4	EAST	1234	2000	394	2000	176.4	200
	CENTER	834	2000	281	2000	183.9	200
	WEST	805	2000	180	2000	198	[illegible]

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RUN 3

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	DEPTH 1/2 READING	1/2 SCALE	DEPTH 2/3 READING	2/3 SCALE
16	EAST	1387	2000	647	2000	468	2000
	CENTER	3.41	20 m	801	2000	444	2000
	WEST	3.14	20 M	898	2000	575	2000
12	EAST	1417	2000	706	2000	506	2000
	CENTER	1102	2000	579	2000	380	2000
	WEST	1082	2000	442	2000	364	2000
8	EAST	1257	2000	418	2000	258	2000
	CENTER	558	2000	264	2000	170.1	200
	WEST	653	2000	332	2000	176.1	200
4	EAST	1122	2000	524	2000	317	2000
	CENTER	1109	2000	412	2000	296	2000
	WEST	751	2000	291	2000	252	2000

19 AUG 85
RUN 4

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	DEPTH 1/2 READING	1/2 SCALE	DEPTH 2/3 READING	2/3 SCALE
16	EAST	1252	2000	665	2000	419	2000
	CENTER	1906	2000	745	2000	413	2000
	WEST	3.09	20 M	855	2000	509	2000
12	EAST	1591	2000	633	2000	339	2000
	CENTER	1149	2000	472	2000	310	2000
	WEST	1341	2000	502	2000	260	2000
8	EAST	1107	2000	327	2000	183.9	200
	CENTER	607	2000	343	2000	183.5	200
	WEST	863	2000	430	2000	312	2000
4	EAST	950	2000	380	2000	237	2000
	CENTER	755	2000	374	2000	256	2000
	WEST	781	2000	366	2000	247	2000

19 AUG 85
RUN 5

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	2.47	20 M	1164	2000	1030	2000
	CENTER	2.67	20 M	1040	2000	621	2000
	WEST	2.91	20 M	1317	2000	1019	2000
12	EAST	1522	2000	968	2000	1178	2000
	CENTER	1255	2000	659	2000	552	2000
	WEST	1502	2000	674	2000	490	2000
8	EAST	1249	2000	358	2000	239	2000
	CENTER	676	2000	278	2000	251	2000
	WEST	409	2000	291	2000	196.9	200
4	EAST	1206	2000	384	2000	252	2000
	CENTER	924	2000	426	2000	214	2000
	WEST	712	2000	307	2000	193	2000

19 AUG 85
RUN 6

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1287	2000	1170	2000	919	2000
	CENTER	1498	2000	1068	2000	353	2000
	WEST	2.79	20 M	1225	2000	709	2000
12	EAST	1400	2000	887	2000	858	2000
	CENTER	1283	2000	782	2000	614	2000
	WEST	1339	2000	845	2000	532	2000
8	EAST	1369	2000	372	2000	317	2000
	CENTER	1053	2000	419	2000	362	2000
	WEST	515	2000	417	2000	338	2000
4	EAST	1019	2000	432	2000	[illegible]	2000
	CENTER	848	2000	472	2000	[illegible]	[illegible]
	WEST	956	2000	524	2000	[illegible]	[illegible]

21 AUG 85
RUN 7

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1057	2000	582	2000	460	2000
	CENTER	1302	2000	917	2000	589	2000
	WEST	1137	2000	1076	2000	739	2000
12	EAST	1054	2000	657	2000	467	2000
	CENTER	1047	2000	655	2000	512	2000
	WEST	961	2000	761	2000	520	2000
8	EAST	961	2000	592	2000	422	2000
	CENTER	910	2000	489	2000	391	2000
	WEST	768	2000	461	2000	350	2000
4	EAST	956	2000	455	2000	339	2000
	CENTER	741	2000	418	2000	370	2000
	WEST	574	2000	382	2000	317	2000

21 AUG 85
RUN 8

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	945	2000	665	2000	477	2000
	CENTER	1325	2000	821	2000	494	2000
	WEST	1518	2000	1029	2000	647	2000
12	EAST	1151	2000	626	2000	[illegible]	2000
	CENTER	1176	2000	730	2000	503	2000
	WEST	1068	2000	725	2000	486	2000
8	EAST	1184	2000	514	2000	321	2000
	CENTER	812	2000	457	2000	312	2000
	WEST	789	2000	477	2000	317	2000
4	EAST	913	2000	410	2000	273	2000
	CENTER	784	2000	410	2000	309	2000
	WEST	545	2000	336	2000	[illegible]	2000

21 AUG 85
RUN 9

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1189	2000	675	2000	410	2000
	CENTER	1380	2000	807	2000	446	2000
	WEST	1614	2000	841	2000	536	2000
12	EAST	1331	2000	621	2000	571	2000
	CENTER	1280	2000	619	2000	399	2000
	WEST	1174	2000	763	2000	437	2000
8	EAST	1018	2000	493	2000	273	2000
	CENTER	964	2000	492	2000	315	2000
	WEST	779	2000	412	2000	330	2000
4	EAST	868	2000	371	2000	242	2000
	CENTER	539	2000	350	2000	296	2000
	WEST	675	2000	409	2000	307	2000

21 AUG 85
RUN 10

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1379	2000	795	2000	505	2000
	CENTER	1735	2000	1019	2000	552	2000
	WEST	1584	2000	995	2000	672	2000
12	EAST	1310	2000	649	2000	438	2000
	CENTER	1455	2000	701	2000	496	2000
	WEST	1371	2000	793	2000	571	2000
8	EAST	1511	2000	637	2000	405	2000
	CENTER	996	2000	510	2000	348	2000
	WEST	882	2000	437	2000	346	2000
4	EAST	1086	2000	512	2000	[illegible]	[illegible]
	CENTER	973	2000	415	2000	[illegible]	[illegible]
	WEST	697	2000	462	[illegible]	[illegible]	[illegible]

21 AUG 85
RUN 11

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	836	2000	631	2000	550	2000
	CENTER	1289	2000	1055	2000	672	2000
	WEST	1695	2000	1510	2000	1272	2000
12	EAST	1574	2000	795	2000	592	2000
	CENTER	1662	2000	908	2000	598	2000
	WEST	1851	2000	1003	2000	760	2000
8	EAST	1904	2000	877	2000	561	2000
	CENTER	1940	2000	769	2000	498	2000
	WEST	1485	2000	631	2000	430	2000
4	EAST	1565	2000	619	2000	401	2000
	CENTER	1375	2000	572	2000	448	2000
	WEST	1155	2000	502	2000	426	2000

21 AUG 85
RUN 12

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	1076	2000	680	2000	576	2000
	CENTER	1223	2000	884	2000	621	2000
	WEST	1691	2000	1145	2000	1037	2000
12	EAST	5.58	20 M	781	2000	578	2000
	CENTER	1655	2000	729	2000	572	2000
	WEST	1727	2000	943	2000	777	2000
8	EAST	3.84	20 M	570	2000	450	2000
	CENTER	1254	2000	504	2000	403	2000
	WEST	1153	2000	535	2000	441	2000
4	EAST	1593	2000	630	2000	406	2000
	CENTER	1179	2000	604	2000	492	2000
	WEST	1110	2000	550	2000	431	[illegible]

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RUN 13

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	1900	2000	1487	2000	1312	2000
	CENTER	4.35	20 M	1602	2000	1028	2000
	WEST	4.96	20 M	4.04	20 M	3.16	20 M
12	EAST	1747	2000	1114	2000	1211	2000
	CENTER	1869	2000	1146	2000	900	2000
	WEST	1811	2000	1100	2000	681	2000
8	EAST	1525	2000	1298	2000	612	2000
	CENTER	956	2000	586	2000	484	2000
	WEST	933	2000	914	2000	638	2000
4	EAST	1580	2000	1035	2000	627	2000
	CENTER	963	2000	710	2000	441	2000
	WEST	1057	2000	657	2000	378	2000

22 AUG 85
RUN 14

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	2.78	20 M	1545	2000	733	2000
	CENTER	3.1	20 M	1267	2000	354	2000
	WEST	3.34	20 M	2.99	20 M	1.85	20 M
12	EAST	2.32	20 M	960	2000	1194	2000
	CENTER	2.67	20 M	1050	2000	731	2000
	WEST	2.64	20 M	1251	2000	680	2000
8	EAST	2.14	20 M	869	2000	830	2000
	CENTER	4.81	20 M	657	2000	465	2000
	WEST	1215	2000	742	2000	535	2000
4	EAST	3	20 M	971	2000	579	2000
	CENTER	1068	2000	729	2000	[illegible]	2000
	WEST	1724	2000	705	2000	[illegible]	2000

22 AUG 85
RUN 15

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	3.3	20 M	1538	2000	841	2000
	CENTER	4.02	20 M	1354	2000	824	2000
	WEST	5.19	20 M	3.18	20 M	1.65	20 M
12	EAST	1518	2000	1027	2000	885	2000
	CENTER	1729	2000	997	2000	618	2000
	WEST	2.76	20 M	1126	2000	582	2000
8	EAST	3.38	20 M	919	2000	1225	2000
	CENTER	1463	2000	690	2000	469	2000
	WEST	933	2000	653	2000	413	2000
4	EAST	1700	2000	1129	2000	421	2000
	CENTER	1391	2000	767	2000	394	2000
	WEST	1949	2000	819	2000	418	2000

22 AUG 85
RUN 16

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	3.14	20 M	1766	2000	938	2000
	CENTER	3.02	20 M	1201	2000	741	2000
	WEST	4.03	20 M	3.37	20 M	2.04	20 M
12	EAST	3.05	20 M	1260	2000	866	2000
	CENTER	2.34	20 M	1103	2000	642	2000
	WEST	2.87	20 M	1216	2000	664	2000
8	EAST	2.88	20 M	1015	2000	544	2000
	CENTER	1805	2000	678	2000	365	2000
	WEST	1286	2000	715	2000	429	2000
4	EAST	1773	2000	1018	2000	394	2000
	CENTER	1390	2000	631	2000	368	2000
	WEST	1467	2000	645	2000	333	2000

22 AUG 85
RUN 17

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	4.84	20 M	1633	2000	1018	2000
	CENTER	4.13	20 M	1391	2000	696	2000
	WEST	5.33	20 M	3.72	20 M	3.01	20 M
12	EAST	3.57	20 M	1350	2000	1021	2000
	CENTER	3.77	20 M	1508	2000	884	2000
	WEST	3.65	20 M	1281	2000	745	2000
8	EAST	3.3	20 M	1123	2000	710	2000
	CENTER	3.54	20 M	887	2000	517	2000
	WEST	1907	2000	937	2000	625	2000
4	EAST	1573	2000	1205	2000	546	2000
	CENTER	1576	2000	716	2000	423	2000
	WEST	1576	2000	1176	2000	696	2000

22 AUG 85
RUN 18

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	11.43	20 M	1685	2000	1406	2000
	CENTER	6.1	20 M	1982	2000	1032	2000
	WEST	8.46	20 M	7.09	20 M	5.37	20 M
12	EAST	4.98	20 M	1750	2000	1265	2000
	CENTER	5.16	20 M	1753	2000	914	2000
	WEST	5.18	20 M	1842	2000	989	2000
8	EAST	6.85	20 M	1541	2000	888	2000
	CENTER	3.7	20 M	981	2000	600	2000
	WEST	3.9	20 M	1053	2000	442	2000
4	EAST	2.48	20 M	1419	2000	639	2000
	CENTER	1674	2000	942	2000	481	2000
	WEST	1991	2000	962	2000	407	2000

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RUN 19 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	902	2000	1081	2000	6.75	20 M
	CENTER	5.11	20 M	3	20 M	947	2000
	WEST	3.91	20 M	3.73	20 M	1046	2000
12	EAST	1.4	20 M	830	2000	484	2000
	CENTER	4.79	20 M	937	2000	427	2000
	WEST	1848	2000	773	2000	491	2000
8	EAST	1665	2000	596	2000	440	2000
	CENTER	4.43	20 M	750	2000	417	2000
	WEST	972	2000	642	2000	379	2000
4	EAST	729	2000	391	2000	232	2000
	CENTER	705	2000	408	2000	254	2000
	WEST	623	2000	545	2000	310	2000

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RUN 20 DEPTH

DIST (FT)		1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	3.27	20 M	4	20 M	762	2000
	CENTER	4.53	20 M	3.26	20 M	1214	2000
	WEST	3.28	20 M	3.15	20 M	1486	2000
12	EAST	2.91	20 M	813	2000	567	2000
	CENTER	4.55	20 M	937	2000	474	2000
	WEST	3.82	20 M	884	2000	503	2000
8	EAST	1.97	20 M	574	2000	404	2000
	CENTER	3.05	20 M	844	2000	425	2000
	WEST	1257	2000	595	2000	357	2000
4	EAST	1007	2000	454	2000	287	2000
	CENTER	887	2000	465	2000	219	2000
	WEST	832	2000	473	2000	213	2000

23 AUG 85
RUN 21

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	4.15	20 M	2.93	20 M	1062	2000
	CENTER	4.96	20 M	1639	2000	1142	2000
	WEST	5.44	20 M	4.5	20 M	1650	2000
12	EAST	5.28	20 M	910	2000	659	2000
	CENTER	4.2	20 M	1035	2000	557	2000
	WEST	4.81	20 M	940	2000	418	2000
8	EAST	1610	2000	578	2000	369	2000
	CENTER	1783	2000	829	2000	453	2000
	WEST	1119	2000	688	2000	414	2000
4	EAST	999	2000	480	2000	313	2000
	CENTER	855	2000	432	2000	273	2000
	WEST	1012	2000	602	2000	368	2000

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RUN 22

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	3.71	20 M	3.62	20 M	1245	2000
	CENTER	4.4	20 M	3.04	20 M	1470	2000
	WEST	5.47	20 M	4.61	20 M	3.21	20 M
12	EAST	4.04	20 M	839	2000	597	2000
	CENTER	5.66	20 M	1108	2000	549	2000
	WEST	4.16	20 M	827	2000	498	2000
8	EAST	1687	2000	587	2000	429	2000
	CENTER	5.41	20 M	600	2000	387	2000
	WEST	1061	2000	596	2000	474	2000
4	EAST	1438	2000	591	2000	[illegible]	2000
	CENTER	1866	2000	595	2000	301	2000
	WEST	927	2000	492	2000	[illegible]	[illegible]

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RUN 23

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16	EAST	3.92	20 M	3.38	20 M	2.55	20 M
	CENTER	4.69	20 M	3.47	20 M	3.15	20 M
	WEST	6.19	20 M	8.66	20 M	8.09	20 M
12	EAST	2.19	20 M	1015	2000	1014	2000
	CENTER	11.01	20 M	1883	2000	894	2000
	WEST	4.09	20 M	1282	2000	925	2000
8	EAST	4.51	20 M	752	2000	699	2000
	CENTER	4.5	20 M	1080	2000	861	2000
	WEST	1143	2000	862	2000	749	2000
4	EAST	1528	2000	712	2000	508	2000
	CENTER	4.04	20 M	674	2000	523	2000
	WEST	1148	2000	728	2000	570	2000

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RUN 24

DIST (FT)		DEPTH 1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
[illegible]	EAST	7.96	20 M	3.85	20 M	3.17	20 M
	CENTER	5.09	20 M	2.96	20 M	3.2	20 M
	WEST	5.27	20 M	6.54	20 M	7.88	20 M
1[illegible]	EAST	3.31	20 M	952	2000	873	2000
	CENTER	4.1	20 M	1432	2000	1010	2000
	WEST	5.68	20 M	1369	2000	979	2000
8	EAST	2.72	20 M	949	2000	704	2000
	CENTER	1610	2000	793	2000	652	2000
	WEST	1658	2000	977	2000	746	2000
4	EAST	3.94	20 M	671	2000	[illegible]	2000
	CENTER	1834	2000	559	2000	522	2000
	WEST	1035	2000	735	2000	538	2000

24 AUG 85
RUN 25

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
		DEPTH					
16	EAST	8.11	20 M	4.38	20 M	2.49	20 M
	CENTER	6.5	20 M	4.12	20 M	1205	2000
	WEST	8.07	20 M	4.44	20 M	2.42	20 M
12	EAST	3.6	20 M	877	2000	741	2000
	CENTER	1929	2000	1052	2000	789	2000
	WEST	1372	2000	995	2000	843	2000
8	EAST	2.16	20 M	593	2000	503	2000
	CENTER	690	2000	627	2000	444	2000
	WEST	685	2000	475	2000	571	2000
4	EAST	1.93	20 M	507	2000	404	2000
	CENTER	931	2000	519	2000	367	2000
	WEST	641	2000	435	2000	406	2000

24 AUG 85
RUN 26

DIST (FT)		1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
		DEPTH					
16	EAST	4.07	20 M	6.84	20 M	3.36	20 M
	CENTER	6.98	20 M	6.19	20 M	1219	2000
	WEST	9.22	20 M	7.19	20 M	2.83	20 M
12	EAST	2.71	20 M	1231	2000	728	2000
	CENTER	2.8	20 M	1160	2000	855	2000
	WEST	1981	2000	1144	2000	777	2000
8	EAST	6.95	20 M	677	2000	439	2000
	CENTER	775	2000	595	2000	511	2000
	WEST	918	2000	700	2000	508	2000
4	EAST	1366	2000	546	2000	389	2000
	CENTER	1097	2000	636	2000	415	2000
	WEST	913	2000	616	2000	432	2000

24 AUG 85
RUN 27

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	6.85	20 M	8.14	20 M	4.21	20 M
	CENTER	8.04	20 M	6.52	20 M	1365	2000
	WEST	10.81	20 M	7.21	20 M	3.47	20 M
12	EAST	1961	2000	1087	2000	837	2000
	CENTER	3.55	20 M	1259	2000	974	2000
	WEST	2.53	20 M	1298	2000	850	2000
8	EAST	828	2000	581	2000	483	2000
	CENTER	729	2000	629	2000	545	2000
	WEST	983	2000	710	2000	585	2000
4	EAST	3.78	20 M	548	2000	433	2000
	CENTER	932	2000	607	2000	447	2000
	WEST	784	2000	560	2000	424	2000

24 AUG 85
RUN 28

DIST (FT)		DEPTH 1/3 READING	SCALE	1/2 READING	SCALE	2/3 READING	SCALE
16	EAST	7.85	20 M	9.25	20 M	4.3	20 M
	CENTER	9.74	20 M	6.87	20 M	1869	2000
	WEST	11.35	20 M	8.83	20 M	4.38	20 M
12	EAST	2.62	20 M	1556	2000	929	2000
	CENTER	4.57	20 M	1605	2000	1220	2000
	WEST	4.18	20 M	1553	2000	1032	2000
8	EAST	1783	2000	804	2000	645	2000
	CENTER	1441	2000	845	2000	625	2000
	WEST	1227	2000	786	2000	620	2000
4	EAST	1779	2000	854	2000	564	2000
	CENTER	1453	2000	692	2000	562	2000
	WEST	1381	2000	698	2000	459	2000

24 AUG 85
RUN 29

DEPTH

DIST (FT)	1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16 EAST	5.51	20 M	7.44	20 M	3.02	20 M
CENTER	8.31	20 M	6.47	20 M	1598	2000
WEST	10.46	20 M	7.42	20 M	3.3	20 M
12 EAST	4.03	20 M	1186	2000	795	2000
CENTER	4.07	20 M	1534	2000	1046	2000
WEST	4.42	20 M	1714	2000	1082	2000
8 EAST	1863	2000	981	2000	629	2000
CENTER	1385	2000	777	2000	645	2000
WEST	1605	2000	949	2000	809	2000
4 EAST	1535	2000	764	2000	437	2000
CENTER	1747	2000	812	2000	557	2000
WEST	1615	2000	750	2000	559	2000

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RUN 30

DEPTH

DIST (FT)	1/3 READING	1/3 SCALE	1/2 READING	1/2 SCALE	2/3 READING	2/3 SCALE
16 EAST	4.56	20 M	6.76	20 M	4.26	20 M
CENTER	7.79	20 M	5.45	20 M	1377	2000
WEST	8.24	20 M	5.61	20 M	2.81	20 M
12 EAST	1.93	20 M	942	2000	356	2000
CENTER	3.37	20 M	1430	2000	1047	2000
WEST	4.92	20 M	1429	2000	792	2000
8 EAST	5.72	20 M	983	2000	652	2000
CENTER	1620	2000	894	2000	615	2000
WEST	1933	2000	943	2000	692	2000
4 EAST	1626	2000	646	2000	391	2000
CENTER	1405	2000	710	2000	455	2000
WEST	1432	2000	701	2000	[illegible]	2000

DATA OF RESISTANCE-VS-TIME FOR LIQUID SAMPLES
REVERSE OSMOSIS WATER (4 liters)
12 SEP 85
DRY SAND @11,580 OHMS / 400 OHMS ON X10K SCALE

TIME(MIN)	RESISTANCE (OHMS)	TIME(MIN)	RESISTANCE (OHMS) X10 K
0	8810	0	200
1	8700	1	200
2	8550	2	200
3	8490	3	200
4	8570	4	200
5	8460	5	200
6	8530	6	200
7	8450	7	200
8	8360	8	225
9	8300	9	200
10	8250	10	200
11	8180	11	200
12	8180	12	200
13	8040	13	200
14	7940	14	200
15	7870	15	200
16	7840	16	200
17	7770	17	200
18	7770	18	225
19	7770	19	200
20	7720	20	200
21	7740	21	200
22	7800	22	250
23	7780	23	250
24	7740	24	225
25	7760	25	225
26	7720	26	225
27	7750	27	225
28	7810	28	225
29	7740	29	225
30	7650	30	225

DATA OF RESISTANCE-VS-TIME FOR LIQUID SAMPLES
LEACHATE (793 ml)
12 SEP 85

TIME(MIN)	RESISTANCE (OHMS)	TIME(MIN)	RESISTANCE (OHMS) X 10K
0	7600	0	225
1	7620	1	225
2	7600	2	225
3	7540	3	250
4	7400	4	250
5	7300	5	250
6	7260	6	250
7	7200	7	250
8	7180	8	250
9	7150	9	250
10	7160	10	250
11	7220	11	250
12	7220	12	250
13	7210	13	250
14	7180	14	250
15	7190	15	250
16	7190	16	250
17	7220	17	250
18	7270	18	250
19	6810	19	250
20	6960	20	300
21	6740	21	275
22	6650	22	275
23	6590	23	275
24	6540	24	300
25	6480	25	275
26	6390	26	275
27	6360	27	275
28	6350	28	300
29	6320	29	300
30	6310	30	300

REVERSE METERS		REVERSE METERS	
1	7180	1	500
2	6670	2	500
3	6540	3	500
4	6570	4	500
5	6490	5	500

DATA OF RESISTANCE-VS-TIME FOR LIQUID SAMPLES
5 mg/l ZINC SULFATE (1500 ml)
12 SEP 85

TIME(MIN)	RESISTANCE (OHMS)	TIME(MIN)	RESISTANCE (OHMS)
0	5580	0	400
1	5850	1	400
2	5460	2	400
3	5340	3	400
4	5120	4	400
5	5170	5	400
6	5090	6	400
7	5070	7	400
8	5030	8	400
9	5020	9	400
10	5010	10	400
11	4980	11	400
12	5030	12	450
13	4970	13	450
14	4970	14	450
15	4920	15	450
16	4930	16	475
17	4970	17	450
18	4990	18	475
19	4920	19	475
20	5010	20	475
21	5010	21	500
22	5010	22	500
23	5020	23	500
24	5150	24	500
25	5130	25	500
26	5140	26	500
27	5120	27	500
28	5110	28	500
29	5110	29	500
30	5120	30	500
55	8440	55	500

REVERSE METERS		REVERSE METERS	
1	9970	1	400
2	9170	2	400
3	9170	3	400
4	9010	4	400
5	8870	5	400

DATA OF RESISTANCE-VS-TIME FOR LIQUID SAMPLES
500 mg/1 ZINC SULFATE (1500 ml)
12 SEP 85

TIME(MIN)	RESISTANCE (OHMS)	TIME(MIN)	RESISTANCE (OHMS)
0	8440	0	450
1	8590	1	450
2	8490	2	450
3	8500	3	475
4	8520	4	475
5	8190	5	450
6	8140	6	450
7	8190	7	475
8	8140	8	475
9	8190	9	475
10	8140	10	475
11	8130	11	475
12	8110	12	475
13	7520	13	450
14	7590	14	500
15	7650	15	500
16	7740	16	500
17	7750	17	475
18	7880	18	475
19	7940	19	475
20	8080	20	475
21	8190	21	500
22	8260	22	500
23	8280	23	500
24	8240	24	500
25	8110	25	500
26	8400	26	500
27	8450	27	500
28	8400	28	500
29	8430	29	500
30	8440	30	500
35	8250	35	500
40	8410	40	500
45	8670	45	500
50	8730	50	500
55	9010	55	500
60	8940	60	500
REVERSE METERS		REVERSE METERS	
1	14100	1	2000
2	13220	2	2000
3	12900	3	2000
4	12640	4	2000
5	11920	5	2000

DATA OF RESISTANCE-VS-TIME FOR LIQUID SAMPLES
CONTINUOUS TIME

TIME (MIN)	RESISTANCE (OHMS)	TIME (MIN)	RESISTANCE (OHMS)	TIME (MIN)	RESISTANCE (OHMS)
0	8810	44	7210	88	5140
1	8700	45	7180	89	5120
2	8550	46	7190	90	5110
3	8490	47	7190	91	5110
4	8570	48	7220	92	5120
5	8460	49	7270	117	8440
6	8530	50	6810	118	8440
7	8450	51	6960	119	8590
8	8360	52	6740	120	8490
9	8300	53	6650	121	8500
10	8250	54	6590	122	8520
11	8180	55	6540	123	8190
12	8180	56	6480	124	8140
13	8040	57	6390	125	8190
14	7940	58	6360	126	8140
15	7870	59	6350	127	8190
16	7840	60	6320	128	8140
17	7770	61	6310	129	8130
18	7770	62	5580	130	8110
19	7770	63	5850	131	7520
20	7720	64	5460	132	7590
21	7740	65	5340	133	7650
22	7800	66	5120	134	7740
23	7780	67	5170	135	7750
24	7740	68	5090	136	7880
25	7760	69	5070	137	7940
26	7720	70	5030	138	8080
27	7750	71	5020	139	[illegible]
28	7810	72	5010	140	8260
29	7740	73	4980	141	8230
30	7650	74	5030	142	8240
31	7600	75	4970	143	8110
32	7620	76	4970	144	[illegible]
33	7600	77	4920	145	[illegible]
34	7540	78	4930	146	8400
35	7400	79	4970	147	[illegible]
36	7300	80	4990	148	8440
37	7260	81	4920	153	8250
38	7200	82	5010	158	8410
39	7180	83	5010	163	8670
40	7150	84	5010	168	8730
41	7160	85	5020	173	[illegible]
42	7220	86	5150	[illegible]	[illegible]
43	[illegible]	87	5130		

METER CHARACTERISTICS LARGE TANK

EAST, SMALL ROD 2/3 DEPTH, 16 FT APART

TIME (MIN)	RESISTANCE (OHMS)
1	591
2	593
3	604
4	600
5	583
6	581
7	580
8	569
9	570
10	569
11	543
12	547
13	537
14	533
15	532

EAST, LARGE ROD, 2/3 DEPTH, 16 FT APART

TIME (MIN)	RESISTANCE (OHMS)
0	785
1	648
2	590
3	533
4	496
5	472
6	456
7	433
8	410
9	393
10	380
11	368
12	368
13	362
14	358
15	355

WEST, SMALL ROD 2/3 DEPTH, 4 FT APART

TIME (MIN)	RESISTANCE (OHMS)
0	552
1	536
2	611
3	582
4	556
5	553
6	543
7	536
8	547
9	547
10	540
11	534
12	520
13	533
14	530
15	523

WEST, LARGE ROD, 2/3 DEPTH 4 FT APART

TIME (MIN)	RESISTANCE (OHMS)
0	263
1	190.9
2	181.8
3	174.4
4	170.6
5	165.9
6	163.3
7	159.4
8	156.6
9	154.7
10	151.9
11	149.3
12	147.7
13	146.6
14	145.9
15	144.1

LEACHATE BLOCK MOISTURE SUMMARY

Date	Locations	Pre-Data Moisture Content (%)	Post-Data Moisture Content (%)	Notes
Mon 5 Aug 85	Surface	0.132	0.023	5 runs in 7 hours
	6"	0.460	0.595	
	18"	0.370	0.173	
	24"	15.152	8.161	
Tues 6 Aug 85	Surface	0.038	0.085	8 runs in 6 hrs.-15 min.
	6"	0.599	0.999	
	18"	0.1818	0.765	
	24"	5.622	9.761	
Wed 7 Aug 85	Surface	0.083	0.011	5 runs in 7 hrs.-15 min.
	6"	0.266	0.217	
	18"	0.303	0.281	
	24"	7.685	1.313	
Thurs 8 Aug 85	Surface	0.071	0.012	6 runs in 7 hrs. and 45 min.
	6"	0.143	0.197	
	18"	0.371	0.250	
	24"	4.658	9.244	
Fri 9 Aug 85	Surface	0.361	0.017	6 runs in 7 hrs. and 30 min.
	6"	0.160	0.058	
	18"	1.331	1.783	
	24"	12.142	15.407	

GELATIN BLOCK MOISTURE SUMMARY

Date	Locations	Pre-Data Moisture Content (%)	Post-Data Moisture Content (%)	Notes
Mon 12 Aug 85	Surface	0.069	0.008	6 runs in. 9 hours
	6"	0.082	0.166	
	18"	1.730	0.067	
	24"	12.317	9.606	
Tues 13 Aug 85	Surface	0.115	0.116	6 runs in 6 hrs.-15 min.
	6"	0.135	0.085	
	18"	0.183	0.380	
	24"	13.090	15.486	
Wed 14 Aug 85	Surface	0.014	0.041	6 runs in 8 hours
	6"	0.039	0.03711	
	18"	0.0393	0.086	
	24"	10.226	6.922	
Thurs 15 Aug 85	Surface	0.046	0.035	6 runs in 6 hours
	6"	0.085	0.102	
	18"	0.722	0.111	
	24"	13.340	9.241	
Fri 16 Aug 85	Surface	0.012	0.038	6 runs in 6 hours
	6"	0.077	0.019	
	18"	0.233	0.273	
	24"	12.227	12.294	

COPPER LEACHATE BLOCK MOISTURE SUMMARY

Date	Locations	Pre-Data Moisture Content (%)	Post-Data Moisture Content (%)	Notes
	Surface	0.026	0.018	
Mon	6"	0.025	0.136	6 runs in 5
19 Aug 85	18"	0.014	0.102	hrs. and 35
	24"	12.041	12.467	min.
	Surface	0.013	0.063	
Wed	6"	0.026	0.121	6 runs in 5
21 Aug 85	18"	0.361	0.141	hours and 45
	24"	9.340	8.553	min.
	Surface	0.114	0.097	
Thurs	6"	0.034	0.045	6 runs in 5
22 Aug 85	18"	0.413	0.678	hours and 55
	24"	9.934	10.012	min.
	Surface	0.058	0.009	
Fri	6"	0.022	0.067	6 runs in 6
23 Aug 85	18"	0.059	0.037	hours and 5
	24"	10.829	6.694	min.
	Surface	0.016	0.032	
Sat	6"	0.088	0.021	6 runs in
24 Aug 85	18"	0.216	1.247	hours and
	24"	7.033	1.023	min.

Evaporation Studies
Dish #1 - Station #1 - Inside Large Tank
$A = 8.62\ in^2$

Date	Evaporation Rate (ml/in^2-hr)
12 July 85	0.054
15 July 85	0.023
16 July 85	0.049
17 July 85	0.018
18 July 85	0.039
19 July 85	0.024
20 July 85	0.053
23 July 85	0.026
26 July 85	0.012
27 July 85	0.041
29 July 85	0.022
31 July 85	0.008
1 Aug 85	0.192
5 Aug 85	-
6 Aug 85	0.031
7 Aug 85	0.012
8 Aug 85	0.018
9 Aug 85	0.016
12 Aug 85	0.017
13 Aug 85	0.019
14 Aug 85	0.027
15 Aug 85	0.035
16 Aug 85	0.024
17 Aug 85	0.023
19 Aug 85	0.019
21 Aug 85	0.054
22 Aug 85	0.035
23 Aug 85	0.035
24 Aug 85	0.035
25 Aug 85	0.070

Evaporation Studies
Dish #2 - Station #1 - Outside Large Tank
A = 8.62 in^2

Date	Evaporation Rate (ml/in^2-hr)
12 July 85	0.082
15 July 85	0.020
16 July 85	0.075
17 July 85	0.028
18 July 85	0.069
19 July 85	0.041
20 July 85	0.080
23 July 85	0.038
26 July 85	0.010
27 July 85	0.059
29 July 85	0.027
31 July 85	0.011
1 Aug 85	0.200
5 Aug 85	-
6 Aug 85	0.020
7 Aug 85	0.032
8 Aug 85	0.029
9 Aug 85	0.028
12 Aug 85	0.033
13 Aug 85	0.036
14 Aug 85	0.043
15 Aug 85	0.055
16 Aug 85	0.037
17 Aug 85	0.031
19 Aug 85	0.028
21 Aug 85	0.042
22 Aug 85	0.049
23 Aug 85	0.053
24 Aug 85	0.058
25 Aug 85	0.070

Evaporation Studies
Dish #3 - Station #18 - Inside Large Tank
$A = 9.62\ in^2$

Date	Evaporation Rate (ml/in^2-hr)
12 July 85	0.083
15 July 85	0.015
16 July 85	0.062
17 July 85	0.027
18 July 85	-
19 July 85	0.017
20 July 85	-
23 July 85	0.028
26 July 85	0.021
27 July 85	0.020
29 July 85	0.025
31 July 85	0.022
1 Aug 85	0.017
5 Aug 85	-
6 Aug 85	0.052
7 Aug 85	0.030
8 Aug 85	0.028
9 Aug 85	0.035
12 Aug 85	0.025
13 Aug 85	0.037
14 Aug 85	0.046
15 Aug 85	0.068
16 Aug 85	0.036
17 Aug 85	0.048
19 Aug 85	0.034
21 Aug 85	0.043
22 Aug 85	0.074
23 Aug 85	0.070
24 Aug 85	0.069
25 Aug 85	0.047

Evaporation Studies
Dish #4 - Surface Aquarium
$A = 9.62\ in^2$

Date	Evaporation Rate (ml/in^2-hr)
12 July 85	0.126
15 July 85	0.050
16 July 85	-
17 July 85	0.036
18 July 85	0.080
19 July 85	0.039
20 July 85	0.037
23 July 85	-
26 July 85	0.012
27 July 85	0.059
29 July 85	0.031
31 July 85	0.012
1 Aug 85	-
5 Aug 85	0.032
6 Aug 85	-
7 Aug 85	-
8 Aug 85	0.027
9 Aug 85	0.029
12 Aug 85	-
13 Aug 85	0.037
14 Aug 85	-
15 Aug 85	0.058
16 Aug 85	0.038
17 Aug 85	0.042
19 Aug 85	0.031
21 Aug 85	0.043
22 Aug 85	0.055
23 Aug 85	0.084
24 Aug 85	0.055
25 Aug 85	0.043

Gelatin Lost Throughout Large Tank Evaluations

Leachate Gelatin Lost (ml)	Date
92.9	5 Aug 85
92.9	6 Aug 85
0	7 Aug 85
123.6	8 Aug 85
279.1	9 Aug 85

Gelatin Lost (ml)	Date
0	12 Aug 85
302.4	13 Aug 85
167.7	14 Aug 85
465.1	15 Aug 85
302.4	16 Aug 85

Copper Leachate Gelatin Lost (ml)	Date
0	19 Aug 85
0	21 Aug 85
0	22 Aug 85
0	23 Aug 85
0	24 Aug 85

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